U.S. Department of Energy
Hanford Site

October 7, 2020

20-ESQ-0106

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Ms. Smith:

CLASS 1 MODIFICATIONS TO THE HANFORD FACILITY RESOURCE CONSERVATION AND RECOVERY ACT PERMIT, QUARTER ENDING SEPTEMBER 30, 2020

In accordance with the Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste (Permit) Condition I.C.3, attached are Class 1 Permit Modification Documents for the quarter ending September 30, 2020.

The attached modifications pertain to: Attachment 4A of the Permit, “Building Emergency Directors/Building Wardens,” Part III of the Permit, “Unit-Specific Conditions for Final Status Operations,” and Part V of the Permit, “Unit-Specific Conditions for Units Undergoing Closure.” The changes to Parts I and II affect information about the status of treatment, storage, and disposal unit groups and permit modification history. The changes to Attachment 4A affect Table 4A-1, “Building Emergency Directors/Building Wardens for Units in the Permit.” The changes to Attachment 9 affect information about the 276-BA Outdoor Storage Area. The changes to Part III affect the Waste Treatment and Immobilization Plant (Operating Unit Group 10) and the Integrated Disposal Facility (Operating Unit Group 11). The changes to Part V affect the PUREX Storage Tunnels (Closure Unit Group 25) and the 276-BA Organic Storage Area (Closure Unit Group 32).

The U.S. Department of Energy and the Washington State Department of Ecology (Ecology) use Permit Change Notices (PCNs) to help track Class 1 Permit Modifications. This modification package addresses the following PCNs:

PCN Identifier:	**Affected Permit Section:**
PCN-4A-2020-01	Attachment 4A
24590-LAW-PCN-ENV-19-008	Appendix 9.2
24590-LAW-PCN-ENV-19-010	Appendix 9.2
PCN-IDF-2020-04	Unit Specific Conditions, Chapter 4.0, Appendix 4A-Section 1, Appendix 4A-Section 3, Appendix 4D and Appendix C9
PCN-PUREX-2019-03	Unit Specific Conditions and Chapter 11
PCN-276-BA-2020-01	Parts I & II, Attachment 9, Unit Specific Conditions, and Addendum H. Updates were made to retire the unit's permit requirements.

The attached changes are based on permittee reviews of Attachment 4A performed during August 2020. Changes affecting Attachment 4A content that emerge after the August 2020 reviews will be addressed in next quarter's Class 1 Modification Package. Please note, pursuant to Permit Condition II.A.4, up-to-date Building Emergency Director/Building Warden information is maintained as described in the unit specific Building Emergency Plans and Facility Response Plans.

Individuals may request hard copies, if the electronic files cannot be accessed. Requests can be made to Ecology by contacting Ecology's Resource Center at (509) 372-7950.

If you have any questions, please contact me, or your staff may contact Glyn D. Trenchard, Acting Assistant Manager for Safety and Environment, Richland Operations Office, on (509) 373-4016.

Sincerely,

Digitally signed by Brian T. Vance
DN: cn=Brian T. Vance, o=Office of River Protection, ou=Department of Energy, email=brian.t.vance@orp.doe.gov, c=US
Date: 2020.10.07 16:03:47 -07'00'

Brian T. Vance
Manager

ESQ:ACM

Attachment:
Class 1 Permit Modification Documents

cc: See page 3

cc w/attach:
D. J. Alexander, Ecology (CD ROM)
J. L. Cantu, Ecology (CD ROM)
Administrative Record, TSD: H-0-1, H-0-8,
D-2-11, S-2-1, TS-2-3 (Hardcopy & CD ROM)
Ecology NWP Library (Hardcopy & CD ROM)
Environmental Portal, G3-35 (CD ROM)
HF Operating Record (J. K. Perry, MSA, A3-01)

cc w/o attach:
J. E. Bramson, CHPRC
R. E. Bullock, CHPRC
A. S. Carlson, Ecology
S. L. Dahl, Ecology
S. A. Davis, BNI
E. A. Garcia, CHPRC
M. E. Jones, Ecology
P. W. Martin, CHPRC
M. T. Schanke, CHPRC
D. G. Singleton, CHPRC
B. A. Sparks, BNI
S. A. Thompson, WRPS
E. J. Van Mason, WRPS
M. B. Wilson, MSA

Attachment
Letter Number 20-ESQ-0106

Class 1 Permit Modification Documents

Consisting of 1142 pages including cover sheet

ENCLOSURE

Class 1 Modifications for Quarter Ending September 30, 2020

Consisting of 1141 pages,
including this cover page

Hanford Facility RCRA Permit Modification Notification Forms

Attachment 4A (Building Emergency Directors/Building Wardens), Table 4A-1 (Building Emergency Directors/Building Wardens for Units in the Permit)

Index

Reviewed by ~~DOE Program Officer~~

Environmental ~~Safety~~ and Quality Division — 9/3/2020

Date

Hanford Facility RCRA Permit Modification Form	
Unit: ***Not Applicable***	Permit Part ***Attachment 4A (Building Emergency Directors/Building Wardens)***

Description of Modification:

Table 4A-1 (Building Emergency Directors/Building Wardens for Units in the Permit)

The subject table is being updated pursuant to Permit Condition II.A.4

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:	X			

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

B.6.d. Changes in name, address, or phone number of coordinators or other persons or agencies identified in the plan ..

Modification Concurrence:	Reviewed by Ecology:
[X] Yes [ ] No	Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.14 15:01:13 -07'00' S. N Schleif Date

Instructions:

Revise Attachment 4A, Table 4A-1 as shown herein.

Table 4A-1 Building Emergency Directors/Building Wardens for Units in the Permit

Contractor	Unit	Building Emergency Directors (BED)/Building Wardens (BW)	Building Emergency Plan/Facility Response Plan Location
CH2M HILL Plateau Remediation Company (CHPRC)	400 Area Waste Management Unit/Fast Flux Test Facility	~~Doremus, Will~~ Plunkett, Roy ~~Precechtel, Mike~~ Roberts, Justin	MO294
CHPRC	PUREX Storage Tunnels	~~Doremus, Will~~ Plunkett, Roy ~~Precechtel, Mike~~ Roberts, Justin	MO294, Conference Room BED Emergency Vehicle
CHPRC	Integrated Disposal Facility (IDF)	Duranceau, David Ahlers, Jeff Eng, ~~Shange~~Shane Dehmer, Chris	MO518 MO607
Washington River Protection Solutions LLC (WRPS)	Liquid Effluent Retention Basin and 200 Area Effluent Treatment Facility (ETF)	Angleton, Bill Biddle, Brian Biglin, Shaun Conley, Jeff Demiter, Scott Garner, Mary Ann Guthrie, Mike Noel, Dan Lillie, Glenn Robertson, Wayne	2025-E ETF Control Room
CHPRC	Capsule Storage Area (CSA)	Parker, Jeff	MO232
WRPS	242-A Evaporator	Beaulaurier, Kyle Blair, Bryan Cuttlers, Matthew Ellis, Mark Frisby, Kirk Maygra, Ryan McFerran, Brandon Nielson, Jeffery Wolff, John	Central Shift Office/ Incident Command Post (ICP), 200 East Area

Table 4A-1 Building Emergency Directors/Building Wardens for Units in the Permit

Contractor	Unit	Building Emergency Directors (BED)/Building Wardens (BW)	Building Emergency Plan/Facility Response Plan Location
Pacific Northwest National Laboratory (PNNL)	325 Hazardous Waste Treatment Units	Saueressig, Paul Wandler, Dan Hansen, Eric	325 Building Room 527
Bechtel National, Inc. (BNI)	Waste Treatment and Immobilization Plant (WTP)	Downs, Greg Feather, Sean Hankins, Jeffrey Loveless, JD ~~Nyegard, Josh~~ Sams, Jason Spencer, Terry Zaleski, Michael	Low-Activity Waste Annex, Room ~~211~~A-211
None (Department of Energy [DOE] Only)	300 Area Process Trenches	N/A*	N/A*
None (DOE Only)	183-H Solar Evaporation Basins	N/A*	N/A*

*The Permit does not specify unit-specific contingency plan requirements for the unit group.

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Quarter Ending June 30, 2020 24590-LAW-PCN-ENV-19-008

Hanford Facility RCRA Permit Modification Notification Form
Part III, Operating Unit 10
Waste Treatment and Immobilization Plant

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Page 2 of 3: Hanford Facility RCRA Permit, Part III, Operating Unit 10, Waste Treatment and Immobilization Plant

Modification to the Hanford Site RCRA / WTP Dangerous Waste Permit consisting of updates to Piping and Instrumentation Diagrams for the LAW Melter Feed Process System (LFP), LAW Secondary Offgas / Vessel Vent Process System (LVP), and Radioactive Liquid Waste Disposal System (RLD). Updates performed are in accordance to WAC 173-303-830, Appendix I Modification citation number: A.3., equipment replacement or upgrading with functionality equivalent components (e.g., pipes, valves, pumps, conveyors, controls).

Submitted by Co-Operator:

Robert Haggard 4/22/2020
Robert Haggard *Date*

Reviewed by ORP Program Office:

Digitally signed by Thomas W. Fletcher
Date: 2020.06.09 12:54:01 -07'00' 06/09/2020
Thomas W. Fletcher *Date*

This document has been digitally signed using the Electrosign process.

Document for Signature

Document Number: 24590-LAW-PCN-ENV-19-008 **Rev:** 0

	Participants	Signature	Completed	Status	Result	Comments
Final Approver	**4/22/2020 2:37 PM**					
	Haggard, Robert		4/22/2020 2:44 PM	Completed	Approve	

Quarter Ending June 30, 2020 24590-LAW-PCN-ENV-19-008

Hanford Facility RCRA Permit Modification Notification Form	
Unit: **Waste Treatment and Immobilization Plant**	Permit Part: **Part III, Operating Unit 10**

Description of Modification:

The purpose of this Class [1]1 modification is to provide Piping and Instrumentation Diagrams (P&IDs) for the LAW Melter Feed Process System (LFP), LAW Secondary Offgas/Vessel Vent Process System (LVP), and Radioactive Liquid Waste Disposal System (RLD) for incorporation into Appendix 9.2 of the WTP RCRA permit:

LFP				
1	Replace:	24590-LAW-M6-LFP-00001004, Rev. 1	With:	24590-LAW-M6-LFP-00001004, Rev. 3
2	Replace:	24590-LAW-M6-LFP-00003001, Rev. 0	With:	24590-LAW-M6-LFP-00003001, Rev. 1
3	Replace:	24590-LAW-M6-LFP-00003002, Rev. 0	With:	24590-LAW-M6-LFP-00003002, Rev. 1
4	Replace:	24590-LAW-M6-LFP-00003003, Rev. 0	With:	24590-LAW-M6-LFP-00003003, Rev. 1
5	Replace:	24590-LAW-M6-LFP-00003004, Rev. 1	With:	24590-LAW-M6-LFP-00003004, Rev. 3
6	Replace:	24590-LAW-M6-LFP-00003005, Rev. 0	With:	24590-LAW-M6-LFP-00003005, Rev. 1
7	Replace:	24590-LAW-M6-LFP-00003006, Rev. 1	With:	24590-LAW-M6-LFP-00003006, Rev. 2
LVP				
8	Replace:	24590-LAW-M6-LVP-00001003, Rev. 1	With:	24590-LAW-M6-LVP-00001003, Rev. 2
9	Replace:	24590-LAW-M6-LVP-00002001, Rev. 1	With:	24590-LAW-M6-LVP-00002001, Rev. 2
10	Replace:	24590-LAW-M6-LVP-00002002, Rev. 1	With:	24590-LAW-M6-LVP-00002002, Rev. 2
11	Replace:	24590-LAW-M6-LVP-00002005, Rev. 0	With:	24590-LAW-M6-LVP-00002005, Rev. 1
12	Delete LAW-M6N-LVP-00138 from Appendix 9.2			
13	Replace:	24590-LAW-M6-LVP-00002007, Rev. 0	With:	24590-LAW-M6-LVP-00002007, Rev. 1
14	Replace:	24590-LAW-M6-LVP-00004001, Rev. 2	With:	24590-LAW-M6-LVP-00004001, Rev. 3
15	Replace:	24590-LAW-M6-LVP-00004002, Rev. 3	With:	24590-LAW-M6-LVP-00004002, Rev. 4
16	Replace:	24590-LAW-M6-LVP-00005002, Rev. 4	With:	24590-LAW-M6-LVP-00005002, Rev. 5
RLD				
17	Replace:	24590-LAW-M6-RLD-00001005, Rev. 0	With:	24590-LAW-M6-RLD-00001005, Rev. 1
18	Replace:	24590-LAW-M6-RLD-00002005, Rev. 0	With:	24590-LAW-M6-RLD-00002005, Rev. 1

1. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00001004, Rev. 3) for Melter 1 Feed Vessel LFP-VSL-00002 of the LAW Melter Feed Process System are summarized below.

    a. See 24590-LAW-M6-LFP-00001004, Rev. 2 for intervening revisions.
    b. Addition of Note 19, Revision 2, incorporation of piping and instrumentation diagrams as well as revision to engineering impact evaluation to align with project requirements.
    c. Addition of Note 20, Revision 3, Low-Low-Low alarm added onto instrument LI-1146A.

2. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003001, Rev. 1) for Melter 2 Feed Vessel LFP-VSL-00003 of the LAW Melter Feed Process System are summarized below.

    a. Addition to Note 3, quality level and seismic category of vessel, nozzles, spare nozzles and manways is specified.
    b. Note 11 updated, unnecessary worded comparison of required seismic category of LFP-VSL-00003 to that of anchorage is removed.
    c. Addition of Note 13, stating the minimum distance between restriction orifices is 2 feet.
    d. Addition of Note 14, Revision 1, listing of incorporated changed documents, deleted references, and revisions to references.
    e. Reference 1 updated, inclusion of LAW concentrate receipt process (LCP) system and LAW melter feed process (LFP) system design descriptions.
    f. Deletion of Reference 2, purchase order agreement of vendor-supplied skid.

3. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003002, Rev. 1) for Melter 2 Feed Preparation Vessel LFP-VSL-00003 of the LAW Melter Feed Process System are summarized below.

    a. Addition to Note 3, quality level and seismic category of vessel, nozzles, spare nozzles and manways is specified.
    b. Addition of Note 16, Revision 1, incorporated documentation and revised equipment functions to satisfy project requirements.
    c. Addition of Reference 1, design description of both 24590-LAW-3ZD-LFP-00001 and concentrate receipt process (LCP).

4. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003003, Rev. 1) for Melter 2 Feed Vessel LFP-VSL-00004 of the LAW Melter Feed Process System are summarized below.

    a. Addition to Note 3, quality level and seismic category of vessel, nozzles, spare nozzles and manways is specified.
    b. Note 9 updated, unnecessary worded comparison of required seismic category of LFP-VSL-00004 to that of anchorage is removed.
    c. Addition of Note 11, Revision 1, incorporated documentation and revised references.
    d. Addition of Reference 1, design description of both 24590-LAW-3ZD-LFP-00001 and concentrate receipt process (LCP).

5. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003004, Rev. 3) for Melter 2 Feed Preparation Vessel LFP-VSL-00004 of the LAW Melter Feed Process System are summarized below.

    a. Addition of Note 19, specifies function of HS-214E from E-stop to local stop, aligning with project requirements, added in Rev. 2 of 24590-LAW-M6-LFP-00003004.
    b. Addition of Note 20, specifies the addition of Low-Low alarm on instrument LI02146A in response to 24590-WTP-GCA-MGT-19-00347 in Rev. 3 of 24590-LAW-M6-LFP-00003004.

6. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003005, Rev. 1) for Melter 2 Feed Preparation and Feed Bulge LFP-BULGE-00002 of the LAW Melter Feed Process System are summarized below.

    a. Addition of Note 14, Revision 1, incorporated documentation and revised references.
    b. Addition of Reference 1, design description of both 24590-LAW-3ZD-LFP-00001 and concentrate receipt process (LCP).

7. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LFP-00003006, Rev. 2) for Melter 2 Feed Preparation and Feed Bulge LFP-BULGE-00002 of the LAW Melter Feed Process System are summarized below.

    a. Addition to Note 3, pressure boundary for double containment piping outside of C5V ventilated rooms and secondary containment is specified as quality level Q and seismic category SC-III.
    b. Addition of Note 11, Revision 2, incorporated change document 24590-LAW-M6N-LFP-00063.

8. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00001003, Rev. 2) for LAW Secondary Offgas/Vessel Vent Process System HEPA Filters are summarized below.

    a. Addition of Note 13, pressure drop is to be minimized.
    b. Deletion of Note 14.
    c. Addition of Note 15, specified the quality level of the outside bird screen mesh may be CM.
    d. Addition of Note 16, specified the LVP-V-72922 and -72923 pipe class and acceptance for use.
    e. Addition of Note 17, Revision 2, incorporated documentation and revised references.

9. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00002001, Rev. 2) for LAW Secondary Offgas/Vessel Vent Process System Caustic Scrubber Bypass are summarized below.

    a. Addition of Note 7, PCV control lines specified to be connected to a straight run of pipe 3 to 5 pipe diameters downstream of the nearest flow disturbance (E.G., Tee, Elbow).
    b. Addition of Note 8, specified a pressure drop is to be minimized.

   c. Deletion of Note 9.
   d. Addition of Note 10, specified the quality level of the outside bird screen mesh may be CM.
   e. Addition of Note 11, PCV pipe direction and arrangement as required by vendor in reference 2 are specified.
   f. Addition of Note 12, Revision 2, incorporated documentation and equipment revised.
   g. Addition of Reference 2, design descriptions/drawings of the Pressure Reducing Regulator, 24590-QL-POA-JV05-07-00001, Rev. 00B.

10. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00002002, Rev. 2) for LAW Secondary Offgas/Vessel Vent Process System Caustic Scrubber LVP-SCB-00001 are summarized below.

    a. Deletion of Note 11, pressure drop is to be minimized.
    b. Deletion of Note 13.
    c. Addition of Note 14, Revision 2, incorporated document 24590-LAW-M6N-LVP-00168 and updated ADR revision.

11. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00002005, Rev. 1) for LAW Secondary Offgas/Vessel Vent Process System Transfer Pumps LVP-PMP-00002A/B are summarized below.

    a. Addition of Note 9, incorporated documentation and revised references.
    b. Addition of Reference 1, system description document changed to 24590-LAW-3ZD-LOP-00001.
    c. Addition of Reference 2, 24590-LAW-ADR-M-02-023 Rev 5, LAW Secondary Offgas Vessel Vent process System (LVP).
    d. Addition of Reference 3, 24590-WTP-ADR-M-16-0001 Rev 4, ALARA Design Review for BOF DEP System.

12. Delete LAW-M6N-LVP-00138 from Appendix 9.2, Design Change Notice has been incorporated into Rev 1 of P&ID 24590-LAW-M6-LVP-00002005.

13. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00002007, Rev. 1) for LAW Secondary Offgas/Vessel Vent Process System Stack Discharge Monitoring System are summarized below.

    a. Deletion of Note 10, connections to ISA to be confirmed by vendor design.
    b. Deletion of Note 11, instrumentation by vendor.
    c. Addition of Note 13, specified a section of tubing is to remain insulated and per thermal insulation guide 24590-WTP-GPG-M-021 is classified as “PG”, adjustable to equipment requiring maintenance.
    d. Addition of Note 14, specific tubing inside vendor box is specified as Bechtel supplied.
    e. Addition of Note 15, Revision 1, incorporated documentation and revisions, as well as required energy act stamp.

14. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00004001, Rev. 3) for LAW Secondary Offgas/Vessel Vent Process System Mercury Mitigation Equipment Bypass are summarized below.

    a. Addition of Note 9, Revision 3, 24590-WTP-FC-IN-18-0042 and CCN 308167 are incorporated.
    b. Reference 1 updated, LOP and LVP grammar is changed.

15. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00004002, Rev. 4) for LAW Secondary Offgas/Vessel Vent Process System Mercury Mitigation Equipment LVP-SKID-00001 are summarized below.

    a. Addition to Note 6, it is specified at least one continuous flow path shall have valves in open position to prevent blocking offgas system during operation.
    b. Deletion to Note 11, instruments AE-0406 and -0425 are removed. The subject AEs were NOx monitors that were originally proposed (early in the project design) to be utilized as part of feed forward control for the ammonia dilution skid (associated with the Thermal Catalytic Oxidizer - TCO). These monitors added significant complexity to the ammonia control system. This complexity reduced the overall reliability of the ammonia control. In addition to the added complexity, it was determined that there was insufficient response time to effectively utilize a feedforward scheme (i.e., the offgas reached the TCO too quickly after passing these analyzers). When the sample and response times were factored in, a feedforward control

scheme was determined to not be viable. The favored control strategy was determined to be a straightforward feedback system based on ammonia slip.

c. Deletion of Note 16, simulant injection port flange adapter
d. Addition of Note 22, direction to see associated vendor references for details on some vendor supplied items.
e. Addition of Note 23, warning that inadvertent closure of valve locked open during analyzer operation may cause equipment damage.
f. Addition of Note 24, Revision 4, incorporated documentation and revisions.
g. Addition of Reference 2, 24590-QL-POA-JA03-00008-08-00007 drawing – TDLS co system tubing detail.
h. Addition of Reference 3, 24590-QL-POA-JA03-00008-08-00008 drawing – TDLS co system master tag list.
i. Addition of Reference 4, 24590-QL-POA-JA03-00008-08-00001 drawing – TDLS co system cabinet layout.
j. Addition of Reference 5, 24590-QL-POA-JA03-00008-08-00002 drawing – TDLS co system cabinet layout.
k. Addition of Reference 6, 24590-CD-POA-JA03-00007-07-00019 drawing – Analyzer LVP-AT-0439 LVP-PNL-00012 / sample system tubing schematic diagram.
l. Addition of Reference 7, 24590-CD-POA-JA03-00007-07-00022 drawing – Analyzer LVP-AT-0439 LVP-PNL-00012 / analyzer enclosure general arrangement drawing (exterior).

16. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-LVP-00005002, Rev. 5) for LAW Secondary Offgas/Vessel Vent Process System SCO/SCR Skid are summarized below.

a. Addition of Note 16, specification that the instrument was provided by Bechtel.
b. Addition of Note 17, instruction to see associated vendor references for details for some vendor supplied items.
c. Addition of Note 18, warning that inadvertent closure of valve locked open during analyzer operation may cause equipment damage.
d. Addition of Note 19, Revision 5, incorporated documentation.
e. Addition of Reference 2, 24590-CD-POA-JA03-00007-07-00013 drawing – Analyzer LVP-AT-0522 LVP-PNL-00028 / NH3 calibration gas distribution manifold tubing schematic diagram.
f. Addition of Reference 3, 24590-CD-POA-JA03-00007-07-00008 drawing – Analyzer LVP-AT-0523 LVP-PNL-00027 / sample system tubing schematic diagram.

17. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-RLD-00001005, Rev. 1) for LAW Radioactive Liquid Waste Disposal System Plant Wash & SBS Condensate Collection RLD-BULGE-00004 are summarized below.

a. Addition of Note 11, specified the pipe blind is pipe class S12C.
b. Addition of Note 12, Revision 1, incorporated documentation and revisions.
c. Addition of Reference 1, LAW facility radioactive liquid waste disposal (RLD) system design description 24590-LAW-3ZD-RLD-00001 is specified. 24590-LAW-3ZD-RLD-00001 supersedes, and has replaced, 24590-LAW-3YD-RLD-00001.
d. Addition of Reference 2, 24590-LAW-ADR-M-01-001 Rev 3, ALARA design review of LAW RLD system.
e. Addition of Reference 3, 24590-WTP-ADR-M-16-0001 Rev 4, ALARA design review of BOF DEP system.

18. Significant changes incorporated into the Piping and Instrumentation Diagram (24590-LAW-M6-RLD-00002005, Rev. 1) for LAW Radioactive Liquid Waste Disposal System C3/C5 Sumps RLD-SUMP-00010/11/28 are summarized below.

a. Note 8 updated, location of the pump discharge flanged connections is changed from “south end” to “end” of melter pour caves one and two.
b. Addition of Note 10, specified the function converts sump level in inches to gallons.
c. Addition of Note 11, incorporated documentation and revisions.
d. Addition of Reference 1, LAW facility radioactive liquid waste disposal (RLD) system design description 24590-LAW-3ZD-RLD-00001 is specified. 24590-LAW-3ZD-RLD-00001 supersedes, and has replaced, 24590-LAW-3YD-RLD-00001.
e. Addition of Reference 2, 24590-LAW-ADR-M-01-001, Rev 3, design review of P&IDs including ALARA considerations for RLD system.
f. Addition of Reference 3, 24590-WTP-ADR-J-06-0001, Rev 2, radar level instrumentation.
g. Addition of Reference 4, 24590-WTP-ADR-J-14-0001, Rev 0, thermal connectivity level instrumentation.

Quarter Ending June 30, 2020 24590-LAW-PCN-ENV-19-008

WAC 173-303-830 Modification Class:	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number: A.3.

Enter wording of WAC 173-303-830, Appendix I Modification citation: Equipment replacement or upgrading with functionality equivalent components (e.g., pipes, valves, pumps, conveyors, controls).

Modification Approved/Concur: X Yes ☐ Denied (state reason below)	Reviewed by Ecology:	
Reason for denial:	Stephanie Schleif Digitally signed by Schleif, Stephanie (ECY)	07/22/2020
	S. Schleif	Date

Casey, Dianne

From: Quick, Mark
Sent: Monday, April 20, 2020 12:50 PM
To: Casey, Dianne
Subject: RE: Request for Concurrence for CCN 317060 LAW-PCN-ENV-19-008

I CONCUR.

From: Casey, Dianne <decasey@bechtel.com>
Sent: Monday, April 20, 2020 12:13 PM
To: Quick, Mark <mtquick@bechtel.com>
Subject: Request for Concurrence for CCN 317060 LAW-PCN-ENV-19-008

Attached is letter CCN 317060 for your review and concurrence. If you do not have any changes, simply reply to this email stating that you "CONCUR". If you do have comments or changes, please let me know.

Thank you.

Dianne Casey
Bechtel National, Inc.
Admin. Assistant –Environmental Protection
(509) 371-2236

Casey, Dianne

From:	Davis, Sheila
Sent:	Monday, April 20, 2020 2:03 PM
To:	Casey, Dianne
Subject:	RE: Request Concurrence for CCN 317060 LAW-PCN-ENV-19-008

I concur.

Thanks,
SD

Sheila Davis| Environmental Permitting Manager
Bechtel National, Inc. (BNI) - WTP
O: (509) 827-3185 | C: (571) 839-9533 | E: sadavis@bechtel.com

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From: Casey, Dianne <decasey@bechtel.com>
Sent: Monday, April 20, 2020 1:15 PM
To: Davis, Sheila <sadavis@bechtel.com>
Subject: Request Concurrence for CCN 317060 LAW-PCN-ENV-19-008

Attached is letter CCN 317060 for your review and concurrence. If you do not have any changes, simply reply to this email stating that you "CONCUR". If you do have comments or changes, please let me know.

Thank you.

Dianne Casey
Bechtel National, Inc.
Admin. Assistant –Environmental Protection
(509) 371-2236

From:	Bernier, Cheryl
To:	Casey, Dianne; WTP Correspondence
Cc:	Haggard, Robert
Subject:	RE: PCN Transmittal
Date:	Monday, May 04, 2020 10:05:49 AM

Great, thanks. We'll get that into concurrence.

Cheryl Bernier
Prime Contract Correspondence Coordinator
(509) 371-2936 (Office)
(509) 554-4559 (Mobile)
cabernie@bechtel.com

From: Casey, Dianne <decasey@bechtel.com>
Sent: Monday, May 4, 2020 9:40 AM
To: Bernier, Cheryl <cabernie@Bechtel.com>; WTP Correspondence <wtpcos@Bechtel.com>
Cc: Haggard, Robert <rdhaggar@bechtel.com>
Subject: RE: PCN Transmittal

Ok, Cheryl. Here is the electro-sign paper for CCN 317060 PCN-ENV-19-008

Thank you
Dianne Casey

From: Casey, Dianne
Sent: Monday, May 4, 2020 9:23 AM
To: Bernier, Cheryl <cabernie@Bechtel.com>
Subject: RE: PCN Transmittal

I should have had that paper. Let me look at it again, as I was having problems with adobe and email attachments. If it is still there, I will re-send.

Dianne Casey

From: Bernier, Cheryl <cabernie@Bechtel.com>
Sent: Thursday, April 30, 2020 3:34 PM
To: Casey, Dianne <decasey@bechtel.com>; Haggard, Robert <rdhaggar@bechtel.com>; WTP Correspondence <wtpcos@Bechtel.com>
Subject: RE: PCN Transmittal

Thanks Diane,

From:	Ponte, Brian
To:	WTP Correspondence
Subject:	RE: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Date:	Tuesday, May 05, 2020 10:31:53 AM

Concur

-
Thanks,

Brian D. Ponte
Prime Contracts Manager
Bechtel Corporation
Tel: +1 509 371 2238 / Mob: +1 509 578 6675

From: WTP Correspondence <wtpcos@Bechtel.com>
Sent: Tuesday, May 5, 2020 10:29 AM
To: Ponte, Brian <bponte@Bechtel.com>
Subject: FW: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Importance: High

Resending for concurrence.

Thank-you,

Lauren Brooks-Cannon

Technical Document Specialist for
Correspondence Coordinator
Bechtel National, Inc. (WTP)
Phone: (509) 371-2131
Email: lbrooksc@bechtel.com

From: WTP Correspondence
Sent: Monday, May 04, 2020 10:43 AM
To: Ponte, Brian <bponte@bechtel.com>
Subject: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Importance: High

Attached for review is External Correspondence CCN 317060, "Submittal of Hanford Facility Resource Conservation and Recovery Act Permit Modification Notification 24590-LAW-PCN-ENV-19-008."

From: Taylor, Walter
To: WTP Correspondence
Subject: RE: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Date: Tuesday, May 05, 2020 11:14:49 AM

Concur

From: WTP Correspondence <wtpcos@Bechtel.com>
Sent: Tuesday, May 05, 2020 11:06 AM
To: Taylor, Walter <wtaylor2@Bechtel.com>
Subject: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Importance: High

Attached for review is External Correspondence CCN 317060, "Submittal of Hanford Facility Resource Conservation and Recovery Act Permit Modification Notification 24590-LAW-PCN-ENV-19-008."

Please provide your concurrence and/or comments by responding to this email.

The author has requested that this be expedited; your prompt reply is appreciated.

Thank-you,

Lauren Brooks-Cannon

Technical Document Specialist for
Correspondence Coordinator
Bechtel National, Inc. (WTP)
Phone: (509) 371-2131
Email: lbrooksc@bechtel.com

Casey, Dianne

From: Haggard, Robert
Sent: Tuesday, April 21, 2020 8:18 AM
To: Casey, Dianne
Subject: RE: Concurrence Requested for CCN 317060 LAW-PCN-ENV-19-008

I concur.

Thanks,

Bob Haggard | Environmental Protection Manager
Bechtel National Inc. | WTP Project
T: (509) 371-4496 | C: (509) 430-1094 | E: rdhaggar@bechtel.com

---

From: Casey, Dianne <decasey@bechtel.com>
Sent: Tuesday, April 21, 2020 7:58 AM
To: Haggard, Robert <rdhaggar@bechtel.com>
Subject: Concurrence Requested for CCN 317060 LAW-PCN-ENV-19-008

Attached is letter CCN 317060 for your review and concurrence. If you do not have any changes, simply reply to this email stating that you "CONCUR". If you do have comments or changes, please let me know.

Thank you.

Dianne Casey
Bechtel National, Inc.
Admin. Assistant –Environmental Protection
(509) 371-2236

From: Presti, Felice
To: WTP Correspondence
Cc: Clemetson, Terri Jo (TJ)
Subject: RE: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Date: Tuesday, May 05, 2020 12:00:06 PM

I concur.

Thanks

Felice Presti | Deputy Project Director
Bechtel National Inc. | WTP Project
T: (509) 371 8681 | C: (509) 392 2556 I E: fpresti@bechtel.com

From: WTP Correspondence <wtpcos@Bechtel.com>
Sent: Tuesday, May 5, 2020 11:55 AM
To: Presti, Felice <fpresti@bechtel.com>
Cc: Clemetson, Terri Jo (TJ) <tjclemet@Bechtel.com>
Subject: EXPEDITE! CCN 317060 (Submittal of RCRA Permit Mod Notification -LAW-PCN-ENV-19-008) - for Concurrence
Importance: High

Attached for review is External Correspondence CCN 317060, "Submittal of Hanford Facility Resource Conservation and Recovery Act Permit Modification Notification 24590-LAW-PCN-ENV-19-008."

Please provide your concurrence and/or comments by responding to this email.

The author has requested that this be expedited; your prompt reply is appreciated.

Concurrences Received: Haggard, Ponte, and Taylor

Thank-you,

Lauren Brooks-Cannon

Technical Document Specialist for
Correspondence Coordinator
Bechtel National, Inc. (WTP)
Phone: (509) 371-2131
Email: lbrooksc@bechtel.com

From: Bernier, Cheryl
To: Brooks-Cannon, Lauren
Subject: RE: CCN 317060 - Ready for Final Review
Date: Wednesday, May 06, 2020 8:07:48 AM

I concur and have updated the concurrence sheet.

Cheryl Bernier
Prime Contract Correspondence Coordinator
(509) 371-2936 (Office)
(509) 554-4559 (Mobile)
cabernie@bechtel.com

From: Brooks-Cannon, Lauren <lbrooksc@bechtel.com>
Sent: Wednesday, May 6, 2020 8:01 AM
To: Bernier, Cheryl <cabernie@Bechtel.com>
Subject: CCN 317060 - Ready for Final Review

CCN 317060 has been signed and is ready for final review and PAIL information.

Thank-you,

Lauren Brooks-Cannon

Technical Document Specialist for
Correspondence Coordinator
Bechtel National, Inc. (WTP)
Phone: (509) 371-2131
Email: lbrooksc@bechtel.com

Attachment 2
20-ECD-0029

P&IDs

24590-LAW-M6-LFP-00001004 Rev 3
24590-LAW-M6-LFP-00003001 Rev 1
24590-LAW-M6-LFP-00003002 Rev 1
24590-LAW-M6-LFP-00003003 Rev 1
24590-LAW-M6-LFP-00003004 Rev 3
24590-LAW-M6-LFP-00003005 Rev 1
24590-LAW-M6-LFP-00003006 Rev 2

24590-LAW-M6-LVP-00001003 Rev 2
24590-LAW-M6-LVP-00002001 Rev 2
24590-LAW-M6-LVP-00002002 Rev 2
24590-LAW-M6-LVP-00002005 Rev 1

24590-LAW-M6-LVP-00002007 Rev 1
24590-LAW-M6-LVP-00004001 Rev 3
24590-LAW-M6-LVP-00004002 Rev 4
24590-LAW-M6-LVP-00005002 Rev 5

24590-LAW-M6-RLD-00001005 Rev 1
24590-LAW-M6-RLD-00002005 Rev 1

(18 Pages Including Cover Sheet)

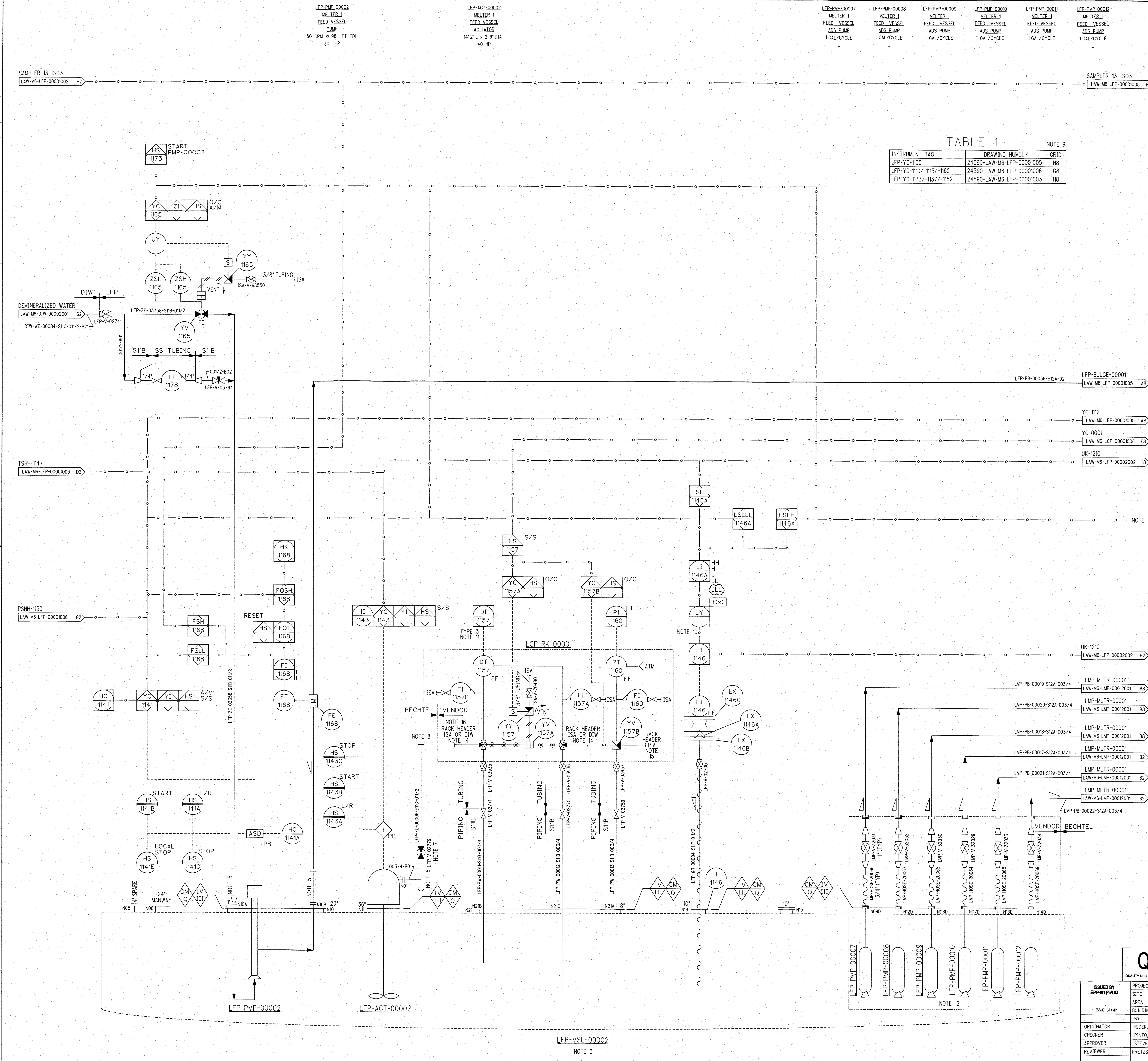

TABLE 1

NOTE 9

INSTRUMENT TAG	DRAWING NUMBER	GRID
LFP-YC-1105	24590-LAW-M6-LFP-00001005	H8
LFP-YC-1110/-1115/-1162	24590-LAW-M6-LFP-00001006	G8
LFP-YC-1133/-1137/-1152	24590-LAW-M6-LFP-00001003	H8

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY (VESSEL AND NOZZLES, INCLUDING SPARE NOZZLES AND MANWAYS) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. REMOVABLE SPOOL TO FACILITATE PUMP REMOVAL.
6. OIL COLLECTION LEG EXTENDS MIN 3 IN BELOW DRAIN/REFILL NOZZLE.
7. LOCATE VALVE, FOR ACCESS, ABOVE ELEVATION 28'-0".
8. THIS CONNECTION ALLOWS MAINTENANCE ACCESS FROM 28 FT FLOOR ELEVATION FOR AGITATOR OIL CHANGE.
9. ICN INTERLOCK ON LFP-VSL-00002 LVL HIHI WILL CLOSE VALVES ASSOCIATED WITH CONTROLLERS LISTED IN TABLE 1.
10. FUNCTION CONVERTS TANK LEVEL IN INCHES TO GALLONS.
11. DENSITY TRANSMITTER SENDS A DIFFERENTIAL PRESSURE VALUE. A CALCULATION IS USED TO DETERMINE DENSITY.
12. FOR ADS PUMP CONTROLS AND ADDITIONAL VESSEL INSTRUMENTATION, SEE DRAWINGS 24590-LAW-M6-LFP-00002002, -00002003, -00002004, -00002005, -00002006, AND -00002007.
13. DELETED
14. FOR ISA AND DIW SUPPLY SEE 24590-LAW-M6-LCP-00001006 COORDINATE C6.
15. FOR ISA SUPPLY SEE 24590-LAW-M6-LCP-00001006 COORDINATE D7.
16. ROUTING OF VENDOR SUPPLIED TUBING WILL BE IDENTIFIED BY C&I PER 24590-WTP-GPG-ENG-0142.
17. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00001, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00001, 24590-LAW-M6N-LFP-00023, -00033 AND 24590-LAW-M6PR-LFP-00001.
18. REVISION 1: INCORPORATED AND FURTHER REVISED 24590-LAW-M6N-20-00024, 24590-LAW-M6N-LFP-00042, -00044, 24590-LAW-M6N-M8OT-00016, -00085, 24590-WTP-M6N-50-00073, 24590-WTP-EIE-J-16-0001 (REV 0), -0008 (REV 0), AND 24590-LAW-EIE-NS-17-0001 (REV 0). ADDED VALVES, PIPE/TUBING BREAKS, BLIND FLANGE TO N15, AND NEW LINE SECTION. REVISED QUALITY DESIGNATOR OF THIS DRAWING FROM Q TO CM, REFERENCE 1, AND ADR REVISION NUMBER ON THE TITLE BLOCK. REMOVED SAFETY RADAR. UPDATED NOTES 9 AND 13. HOSE CONNECTIONS TO HOSE COUPLERS. OFF SHEET CONNECTORS, AND TABLE 1. CHANGED ELECTRICAL SIGNAL TO A DATA LINK BETWEEN FQI-1168 AND FQSH-1168. ADDED REDUCERS AND 1/4" TUBING. MOVED OFF SHEET CONNECTOR FROM G8 TO D8. UPDATED DATA LINK ROUTES.
19. REVISION 2: INCORPORATED 24590-LAW-M6N-LFP-00063, 24590-LAW-M6N-20-00027, AND 24590-LAW-EIE-SYSE-17-0009 REV 0. REVISED FUNCTION OF HS-1141E FROM E-STOP TO LOCAL STOP TO ALIGN WITH PROJECT REQUIREMENTS.
20. REVISION 3: ADDED LOW-LOW-LOW ALARM ON INSTRUMENT LI-1146A IN RESPONSE TO 24590-WTP-GCA-MGT-19-00347.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
3	REVISED PER NOTE 20	JB	BWJ	KDS	AC CMN TRV	6/5/19
2	REVISED PER NOTE 19	CNK	AF	N/A	AL/CN/TV	03/21/19
1	REVISED PER NOTE 18	TH	TV	NK	WJ/SS/JW	7/27/17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 17	RJR	APP	SK/SS	RS/TH	2/15/11

REVISION HISTORY

ISSUED BY RPP-WTP PDC

ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	PINTO, PAT	2/9/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/11

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER FEED PROCESS SYSTEM MELTER 1 FEED VESSEL LFP-VSL-00002

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

SCALE: NONE

24590-LAW-M6-LFP-00001004 REV 3

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11955055

6/3/2019 12:30:23 PM

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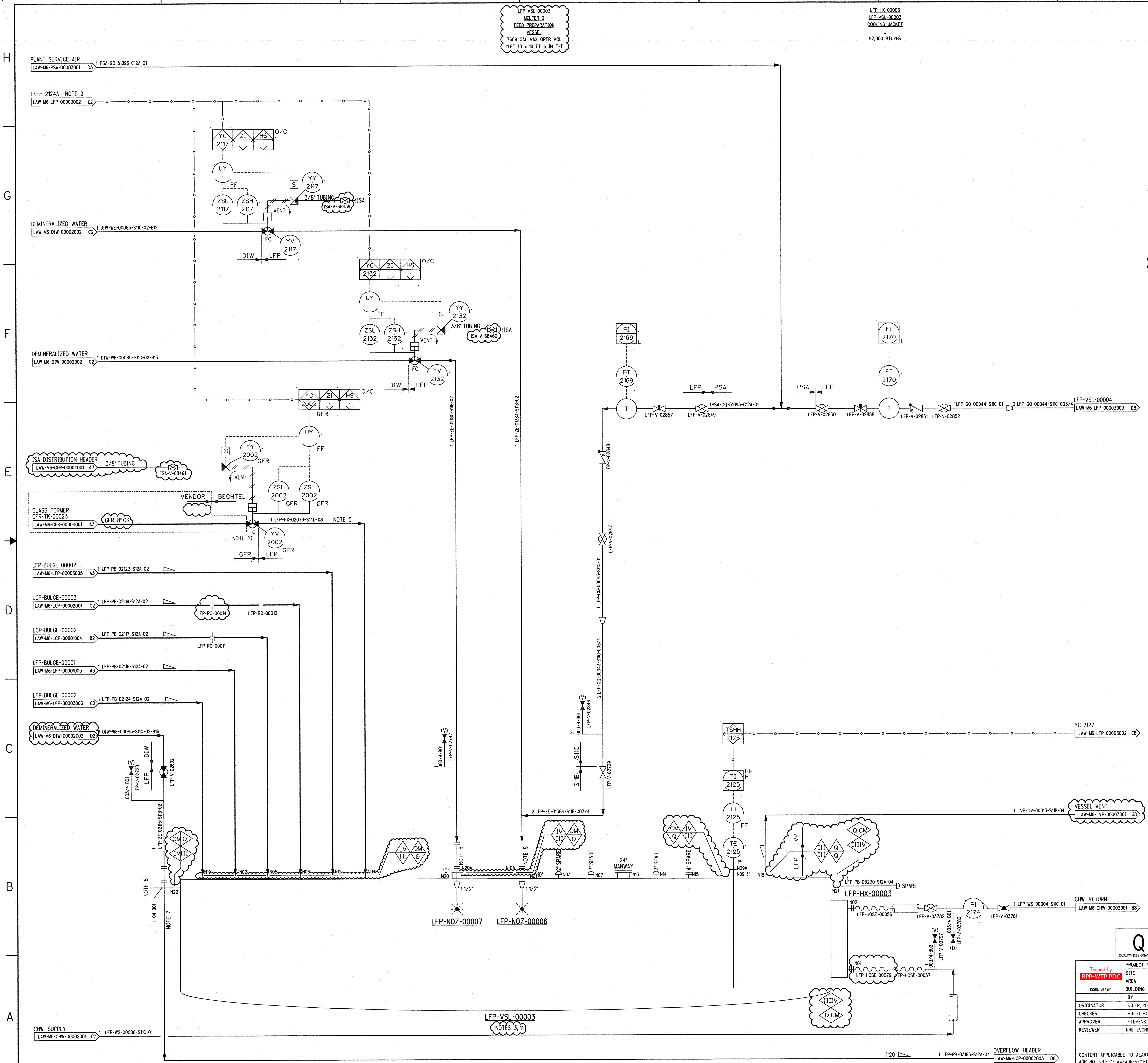
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY (VESSEL AND NOZZLES, INCLUDING SPARE NOZZLES AND MANWAYS) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. MINIMUM ANGLE OF PIPE IS 60 DEGREES FROM HORIZONTAL.
6. A CROSS PIPE FITTING WILL BE USED. REMOVABLE SPOOL PIECE IS TO FACILITATE INSPECTION OF OVERFLOW DOWNCOMER.
7. FOR VESSEL LFP-VSL-00003, MAXIMUM HORIZONTAL DISTANCE BETWEEN DOWNCOMER PIPE AND VESSEL SHELL SHALL NOT BE MORE THAN FIVE PIPE DIAMETERS. CONNECT DEMINERALIZED WATER LINE AT THE TOP FLANGE CONNECTION OF THE CROSS FITTING. STRAIGHT VERTICAL DOWNCOMER RUN SHALL BE A MINIMUM OF SIX FEET.
8. REMOVABLE SPOOL PIECE TO FACILITATE SPRAY NOZZLE REMOVAL.
9. ICN INTERLOCK ON FRP-VSL-00003 LVL HI HI WILL CLOSE VALVES LCP-YC-2117, -2132, GFR-YC-2002, AND STOP INFLOW TO LFP-VSL-00003.
10. FULL PORT BALL VALVE IS REQUIRED FOR GLASS FORMERS.
11. SEISMIC CATEGORY SC-III ANCHORAGE IS REQUIRED. ANCHORAGE SHALL PREVENT VESSEL MOVEMENT THAT COULD DAMAGE CO-LOCATED SAFETY SIGNIFICANT COMPONENTS.
12. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00002, -00004, 24590-LAW-M6LN-LFP-00002, 24590-LAW-M6N-LFP-00015, -00025, -00027, -00031, -00035, AND 24590-WTP-FC-P-07-0362.
13. MINIMUM DISTANCE BETWEEN RESTRICTION ORIFICES IS 2 FEET.
14. REVISION 1: INCORPORATED CHANGE DOCUMENTS 24590-LAW-M6N-LCP-00048, 24590-LAW-M6N-LFP-00044, -00047, -00063, 24590-LAW-M6N-M80T-00016, -00032, -00044 AND 24590-WTP-FC-M-17-0165. DELETED SUPERSEDED REFERENCE 2. REVISED SDD REFERENCE AND ADR REVISION. ADDED CM/Q BOUNDARY AT LFP-VSL-00003 AND LFP-HX-00003 INTERFACE.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.
2. DELETED

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LFP-00003001	LAW MELTER 2 FEED PROCESS SYSTEM LFP-VSL-00003
24590-LAW-M6-LFP-00003002	LAW MELTER 2 FEED PROCESS SYSTEM LFP-VSL-00003
24590-LAW-M6-LFP-00003003	LAW MELTER 2 FEED PROCESS SYSTEM LFP-VSL-00004
24590-LAW-M6-LFP-00003004	LAW MELTER 2 FEED PROCESS SYSTEM LFP-VSL-00004
24590-LAW-M6-LFP-00003005	LAW MELTER 2 FEED PROCESS SYS LFP-BULGE-00002
24590-LAW-M6-LFP-00003006	LAW MELTER 2 FEED PROCESS SYS LFP-BULGE-00002

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 14				TRV	6/5/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 12	RJR	APP	SK/SS	RS/TH	2/15/11

Q
QUALITY DESIGNATOR

Issued by RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	PINTO, PAT	2/10/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER FEED PROCESS SYSTEM
MELTER 2 FEED PREPARATION LFP-VSL-00003

SCALE: NONE | 24590-LAW-M6-LFP-00003001 | REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11961200

6/3/2019 12:39:18 PM

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FORM E_SDN.DGN 02/2009

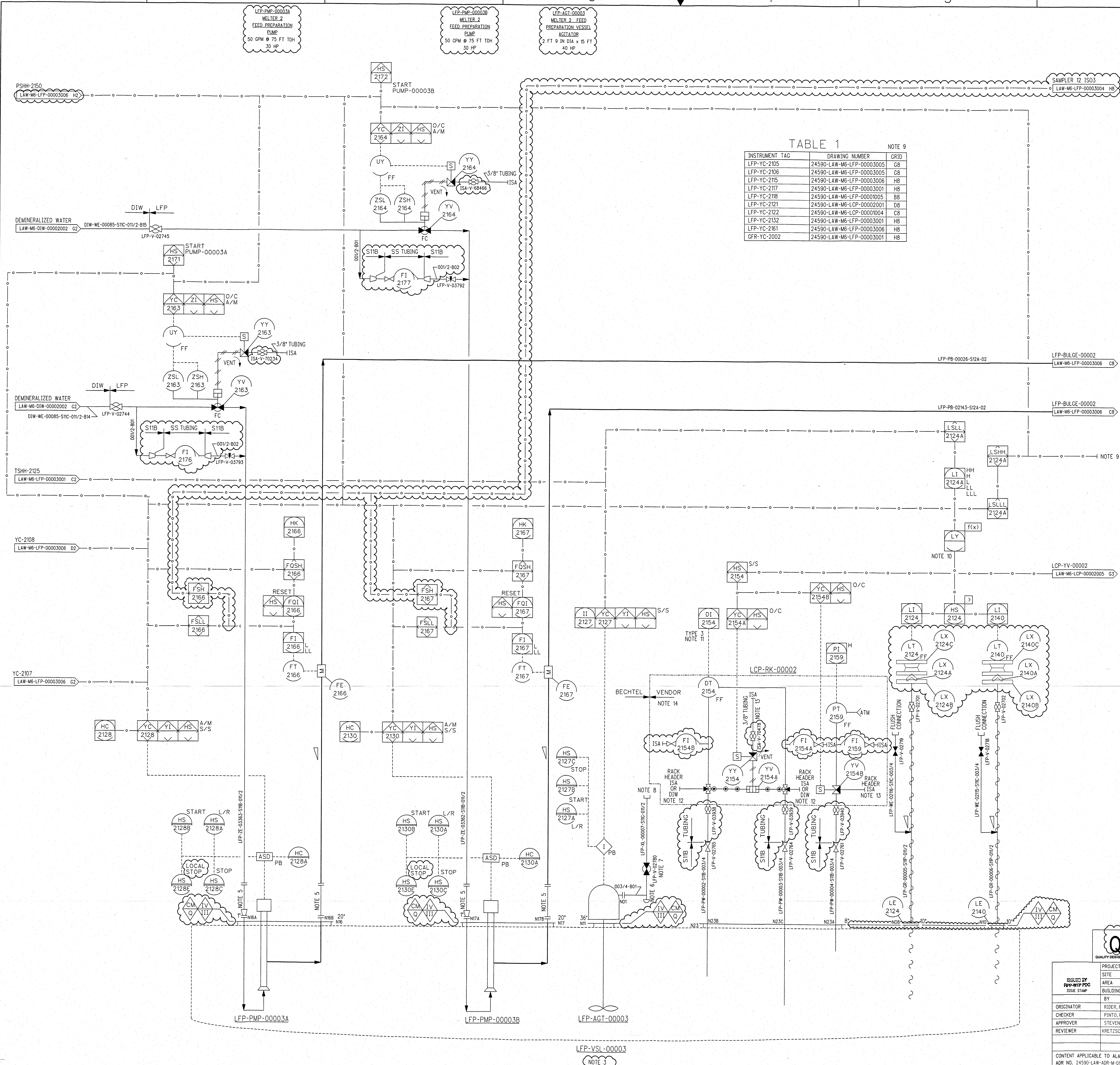

TABLE 1

NOTE 9

INSTRUMENT TAG	DRAWING NUMBER	GRID
LFP-YC-2105	24590-LAW-M6-LFP-00003005	G8
LFP-YC-2106	24590-LAW-M6-LFP-00003005	G8
LFP-YC-2115	24590-LAW-M6-LFP-00003006	H8
LFP-YC-2117	24590-LAW-M6-LFP-00003001	H8
LFP-YC-2118	24590-LAW-M6-LFP-00001005	B8
LFP-YC-2121	24590-LAW-M6-LCP-00002001	D8
LFP-YC-2122	24590-LAW-M6-LCP-00001004	C8
LFP-YC-2132	24590-LAW-M6-LFP-00003001	H8
LFP-YC-2161	24590-LAW-M6-LFP-00003006	H8
GFR-YC-2002	24590-LAW-M6-LFP-00003001	H8

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY (VESSEL AND NOZZLES, INCLUDING SPARE NOZZLES AND MANWAYS) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. REMOVABLE SPOOL TO FACILITATE PUMP REMOVAL.
6. OIL COLLECTION LEG EXTENDS MIN 3 IN BELOW DRAIN/REFILL NOZZLE.
7. LOCATE VALVE, FOR ACCESS, ABOVE ELEVATION 28'-0".
8. THIS CONNECTION ALLOWS MAINTENANCE ACCESS FROM 28 FT FLOOR ELEVATION FOR AGITATOR OIL CHANGE.
9. ON HIGH LEVEL DETECTION (LFP-LSHH-2124A), VALVES LISTED IN TABLE 1 WILL CLOSE AND STOP INFLOW TO LFP-VSL-00003.
10. FUNCTION CONVERTS TANK LEVEL IN INCHES TO GALLONS.
11. DENSITY TRANSMITTER SENDS A DIFFERENTIAL PRESSURE VALUE. A CALCULATION IS USED TO DETERMINE DENSITY.
12. FOR ISA AND DIW SUPPLY SEE 24590-LAW-M6-LCP-00002005 COORDINATE B6.
13. FOR ISA SUPPLY SEE 24590-LAW-M6-LCP-00002005 COORDINATE B7.
14. ROUTING OF VENDOR SUPPLIED TUBING WILL BE IDENTIFIED BY C&I PER 24590-WTP-GPG-ENG-0142.
15. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00001, -00002, 24590-LAW-M6N-LFP-00015, -00021, -00023, -00025, -00026, -00027, -00031, 24590-LAW-M6PR-LFP-00001, AND 24590-WTP-FC-P-07-0362.
16. REVISION 1: INCORPORATED 24590-LAW-M6N-M80T-00016, 24590-LAW-M6N-M80T-00085, 24590-LAW-M6N-20-00024, 24590-LAW-M6N-20-00027, 24590-LAW-M6N-LCP-00048, 24590-LAW-M6N-LFP-00061, 24590-LAW-M6N-LFP-00063, 24590-WTP-M6N-50-00073, 24590-WTP-EIE-J-16-0001 REV 0, 24590-WTP-EIE-J-16-0008 REV 0, AND 24590-LAW-EIE-M-17-0006 REV 0. REVISED FUNCTION OF HS-2128E AND HS-2130E FROM E-STOP TO LOCAL STOP TO ALIGN WITH PROJECT REQUIREMENTS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 16	CNK	OF	N/A	CMN AML TKV	3/21/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 15	RJR	APP	SK/SS	RS/TH	2/15/11

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	PINTO, PAT	2/10/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/2011

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

P&ID - LAW
LAW MELTER FEED PROCESS SYSTEM
MELTER 2 FEED PREPARATION
LFP-VSL-00003

SCALE: NONE

24590-LAW-M6-LFP-00003002 REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11924273

3/19/2019 9:37:06 AM

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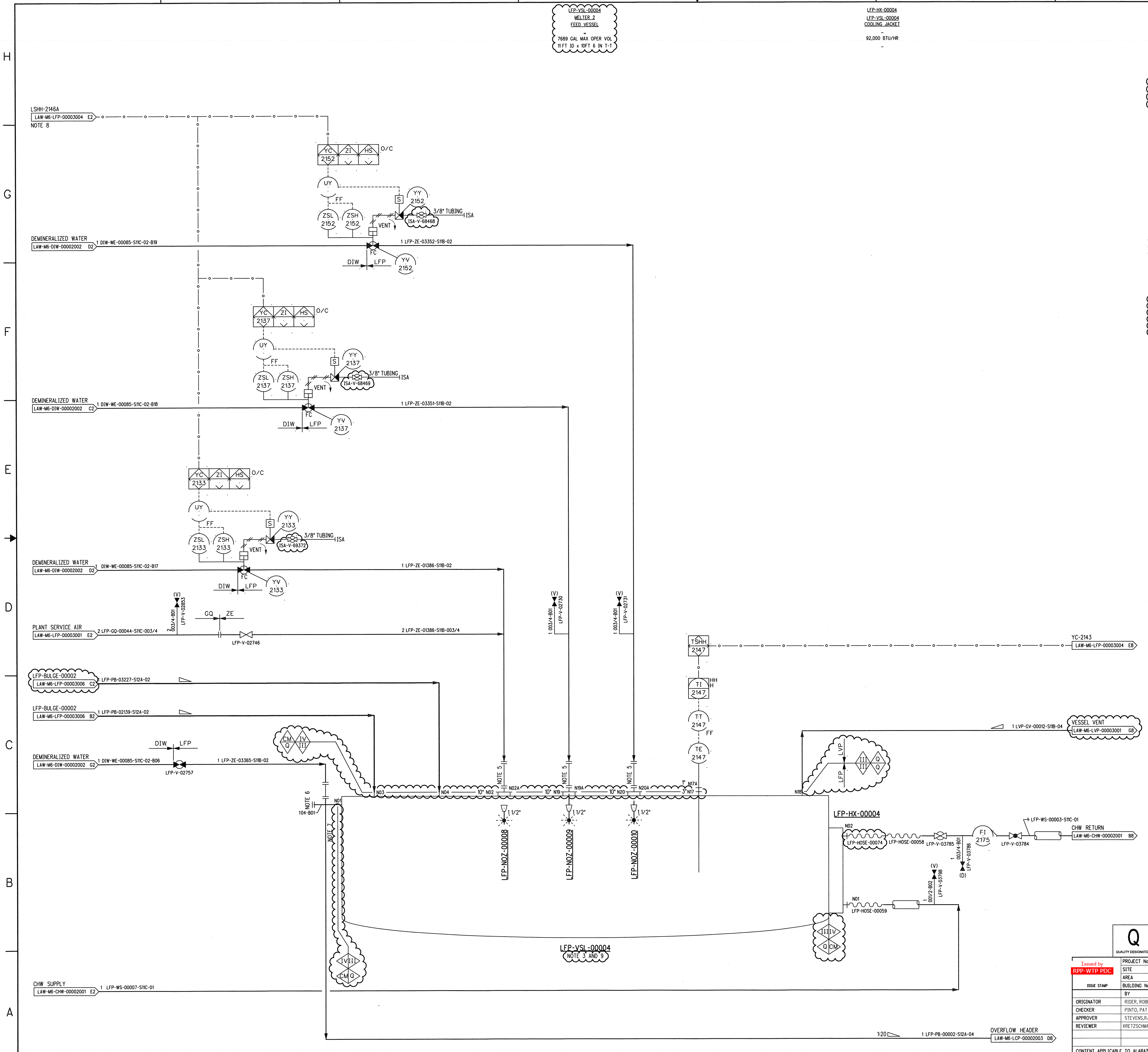
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY (VESSEL AND NOZZLES, INCLUDING SPARE NOZZLES AND MANWAYS) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. REMOVABLE SPOOL PIECE TO FACILITATE SPRAY NOZZLE REMOVAL.
6. A CROSS PIPE FITTING WILL BE USED. REMOVABLE PIECE IS TO FACILITATE INSPECTION OF OVERFLOW DOWNCOMER.
7. FOR VESSEL LFP-VSL-00002, HORIZONTAL DISTANCE BETWEEN DOWNCOMER PIPE AND VESSEL SHELL SHALL BE AS SHORT AS POSSIBLE, NOT EXCEEDING SIX PIPE DIAMETERS. CONNECT DEMINERALIZED WATER LINE AT THE TOP FLANGE CONNECTION OF THE CROSS FITTING. STRAIGHT VERTICAL DOWNCOMER RUN SHALL BE A MINIMUM OF SIX FEET. SLOPE IS NOT REQUIRED AT VESSEL NOZZLE CONNECTION.
8. ICN INTERLOCK ON LFP-VSL-00004 LEVEL HI HI WILL CLOSE VALVES YC-2152, -2137, -2133.
9. SEISMIC CATEGORY SC-III ANCHORAGE IS REQUIRED. ANCHORAGE SHALL PREVENT VESSEL MOVEMENT THAT COULD DAMAGE CO-LOCATED SAFETY SIGNIFICANT COMPONENTS.
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00004, 24590-LAW-M6N-LFP-00015, AND -00035.
11. REVISION 1: INCORPORATED CHANGE DOCUMENTS 24590-LAW-M6N-LCP-00048, 24590-LAW-M6N-LFP-00044, -00063, 24590-LAW-M6N-MB0T-00016 AND 24590-WTP-FC-M-17-0165. REVISED SDD REFERENCE AND ADR REVISION. ADDED CM/Q BOUNDARY AT LFP-VSL-00004 AND LFP-HX-00004 INTERFACE.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 11					6/5/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	RJR	APP	SK/SS	RS/TH	2/15/11

REVISION HISTORY

Issued by RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	PINTO, PAT	2/9/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/11

P&ID - LAW LAW MELTER FEED PROCESS SYSTEM MELTER 2 FEED VESSEL LFP-VSL-00004

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV 4

SCALE: NONE
24590-LAW-M6-LFP-00003003 REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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FORM E_SDN.DGN 02/2009

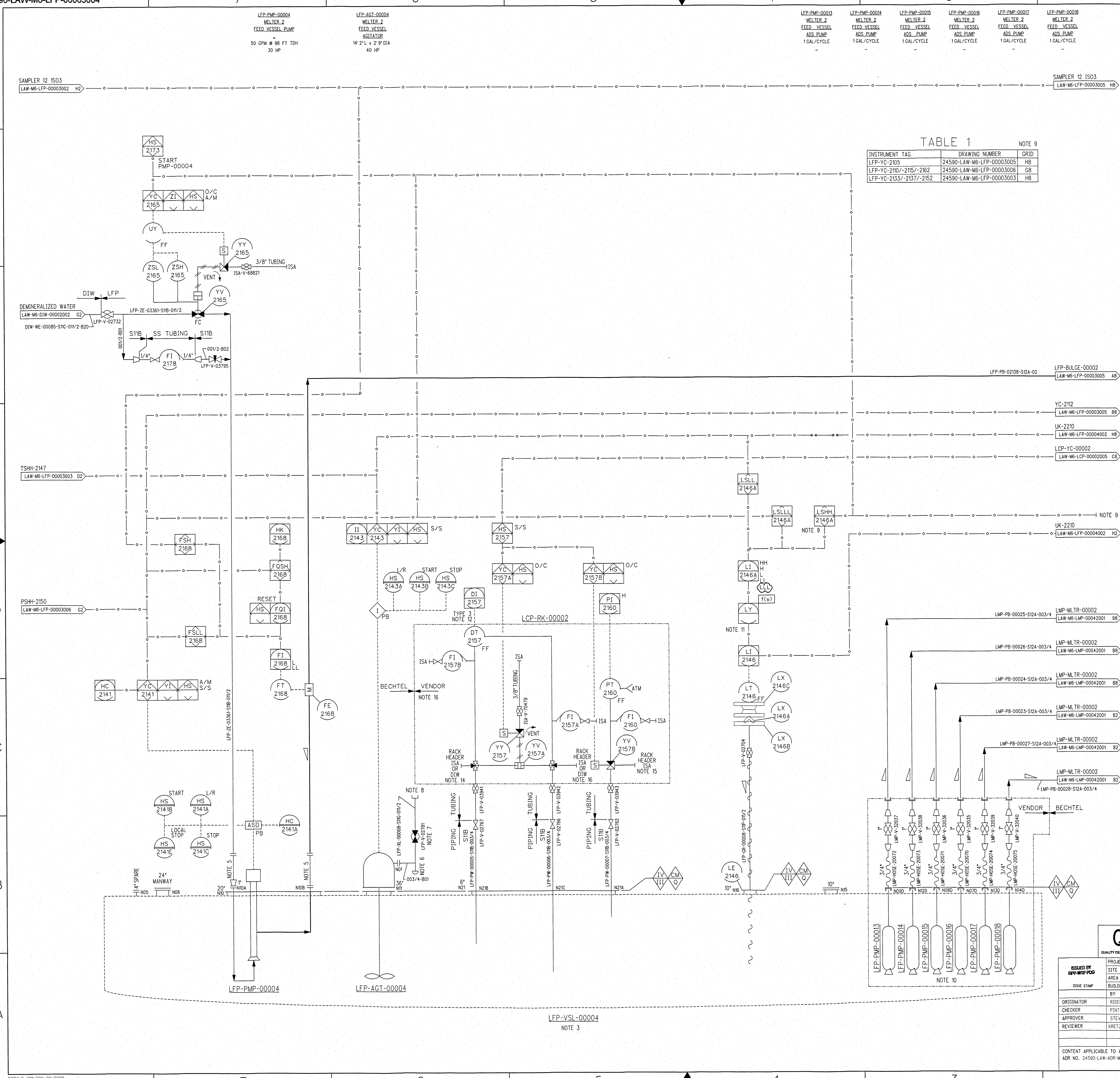

TABLE 1

NOTE 9

INSTRUMENT TAG	DRAWING NUMBER	GRID
LFP-YC-2105	24590-LAW-M6-LFP-00003005	H8
LFP-YC-2110/-2115/-2162	24590-LAW-M6-LFP-00003006	G8
LFP-YC-2133/-2137/-2152	24590-LAW-M6-LFP-00003003	H8

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY (VESSEL AND NOZZLES, INCLUDING SPARE NOZZLES AND MANWAYS) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. REMOVABLE SPOOL PIECE TO FACILITATE PUMP REMOVAL.
6. OIL COLLECTION LEG EXTENDS MIN 3 IN BELOW DRAIN/REFILL NOZZLE.
7. LOCATE VALVE, FOR ACCESS, ABOVE ELEVATION 28'-0".
8. THIS CONNECTION ALLOWS MAINTENANCE ACCESS FROM 28 FT FLOOR ELEVATION FOR AGITATOR OIL CHANGE.
9. ICN INTERLOCK ON VSL-00004 LVL HI HI WILL CLOSE VALVES ASSOCIATED WITH CONTROLLERS LISTED IN TABLE 1.
10. FOR ADS PUMP CONTROLS AND ADDITIONAL VESSEL INSTRUMENTATION, SEE DRAWINGS 24590-LAW-M6-LFP-00004002, -00004003, -00004004, -00004005, -00004006, AND -00004007.
11. FUNCTION CONVERTS TANK LEVEL IN INCHES TO GALLONS.
12. DENSITY TRANSMITTER SENDS A DIFFERENTIAL PRESSURE VALUE. A CALCULATION IS USED TO DETERMINE DENSITY.
13. DELETED
14. FOR ISA AND DIW SUPPLY SEE 24590-LAW-M6-LCP-00002005 COODINATE B6.
15. FOR ISA SUPPLY SEE 24590-LAW-M6-LCP-00002005 COORDINATE B7.
16. ROUTING OF VENDOR SUPPLIED TUBING WILL BE IDENTIFIED BY C&I PER 24590-WTP-GPG-ENG-0142.
17. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00001, 24590-LAW-M6N-LFP-00023, -00035, AND 24590-LAW-M6PR-LFP-00001.
18. REVISION 1: INCORPORATED AND FURTHER REVISED 24590-LAW-M6N-20-00016, -00024, 24590-LAW-M6N-LFP-00042, -00044, 24590-LAW-M6N-M80T-00016, -00085, 24590-WTP-EIE-J-16-0001 (REV 0), -0008 (REV 0), 24590-WTP-M6N-50-00073, AND 24590-LAW-EIE-NS-17-0001 (REV 0). ADDED VALVES AND PIPE/TUBING BREAKS. REVISED REFERENCE 1, ADR REVISION NUMBER ON THE TITLE BLOCK, AND QUALITY DESIGNATOR OF THE DRAWING FROM Q TO CM. REMOVED SAFETY RADAR. UPDATED OFF SHEET CONNECTORS, TABLE 1, HOSE CONNECTIONS TO HOSE COUPLERS, NOTE 9 AND 13. MOVED VENDOR BOUNDARY, DATA LINK TO CONNECT DIRECTLY INTO LI-2146, AND DATA LINK CONNECTION FOR FSLL-2168 TO CONNECT BETWEEN FI-2168 AND FQI-2168. ADDED REDUCERS AND 1/4" TUBING. MOVED OFF SHEET CONNECTOR FROM G8 TO D8. UPDATED DATA LINK ROUTES.
19. REVISION 2: INCORPORATED 24590-LAW-M6N-LFP-00063, 24590-LAW-M6N-20-00027, AND 24590-LAW-EIE-SYSE-17-0009 REV 0. REVISED FUNCTION OF HS-2141E FROM E-STOP TO LOCAL STOP TO ALIGN WITH PROJECT REQUIREMENTS.
20. REVISION 3: ADDED LOW-LOW-LOW ALARM ON INSTRUMENT LI-2146A IN RESPONSE TO 24590-WTP-GCA-MGT-19-00347.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
3	REVISED PER NOTE 20	JB	BWJ	KRJ	AC / TRV	6/5/19
2	REVISED PER NOTE 19	CNK	AF	N/A	AL/CN/TV	03/21/19
1	REVISED PER NOTE 18	TH	TV	NK	WJ/SS/JW	7/27/17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 17	RJR	APP	SK/SS	RS/TH	2/15/11

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	PINTO, PAT	2/11/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/11

CONTENT APPLICABLE TO ALARA? X YES ☐ NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

P&ID - LAW LAW MELTER FEED PROCESS SYSTEM MELTER 2 FEED VESSEL LFP-VSL-00004

SCALE: NONE

24590-LAW-M6-LFP-00003004 REV 3

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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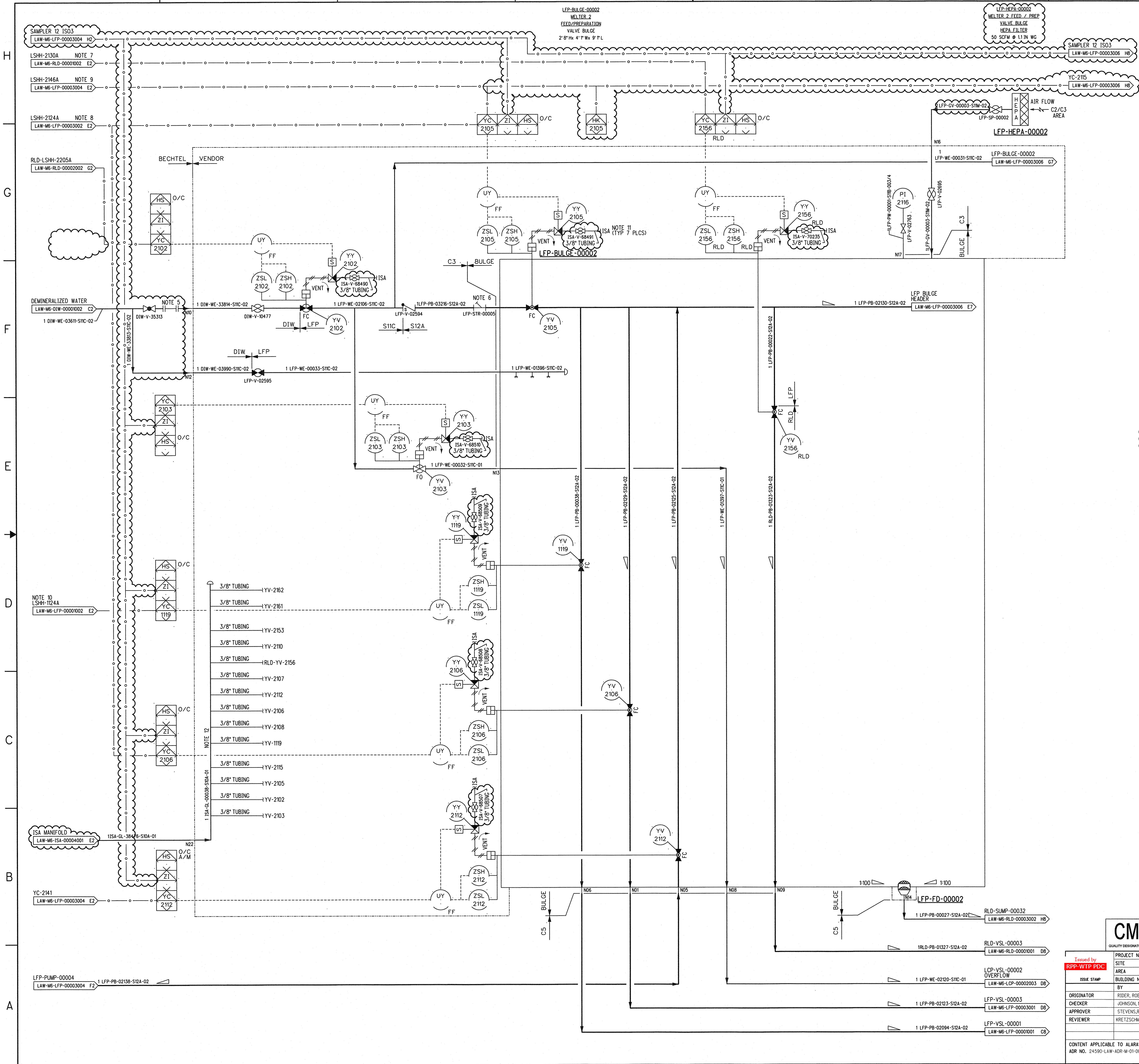

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. SPOOL PIECE CONNECTION FOR THE ADDITION OF PRESSURIZED WATER/CHEMICALS TO CLEAR LINE PLUG UPS. THE SPOOL LENGTH SHALL ACCOMMODATE THE LENGTH OF A TEE WITH FLANGES MATCHING THE PIPE SIZE.
6. POSITION STRAINER (WITHOUT STRAINER INTERNALS) WITH THE PORT IN THE UP POSITION TO ALLOW FOR LINE CLEANING.
7. PLANT WASH VESSEL HIGH HIGH LEVEL CLOSES VALVES RLD-YV-2105, -2108, -2117, -2109, -2106, -2118, -2120, -2121, -2122, -2123, -2156, -2173, -2174, STOPS RLD-PMP-00004, -00025, -00026, -00027, -00028, -00031, -00032, AND CLOSES NLD-YV-2018.
8. ICN INTERLOCK ON LFP-VSL-00003 LEVEL HI HI WILL CLOSE VALVES YV-2105, YV-2106, AND STOP PUMPS.
9. ICN INTERLOCK ON LFP-VSL-00004 LEVEL HI HI WILL CLOSE VALVE YV-2105.
10. ICN INTERLOCK ON LFP-VSL-00001 LEVEL HI HI WILL CLOSE VALVE YV-1119 AND STOP PUMP.
11. FOR ISA SUPPLY, SEE THIS DRAWING.
12. FOR YV'S NOT ON THIS DRAWING, SEE CONNECTIONS ON 24590-LAW-M6-LFP-00003006.
13. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LFP-00015, -00016, -00026, -00035, AND 24590-LAW-M6LN-20-00002.
14. REVISION 1: INCORPORATED CHANGE DOCUMENTS 24590-LAW-M6N-LFP-00044, -00050, -00060, 24590-LAW-M6N-M80T-00016, -00085, AND 24590-LAW-M6N-LCP-00048. REVISED SDD REFERENCE AND ADR REVISION.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 14	[illegible]	YM	N/A	[illegible]	6/5/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 13	RJR	NTJ	SK/SS	RS/TH	2/15/11

REVISION HISTORY

CM
QUALITY DESIGNATOR

Issued by
RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/9/11
CHECKER	JOHNSON, NGA T	2/9/11
APPROVER	STEVENS,R/HUGHES,T	2/15/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/14/11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER FEED PROCESS SYSTEM MELTER 2 FEED PREPARATION AND FEED LFP-BULGE-00002

SCALE: NONE

24590-LAW-M6-LFP-00003005

REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

FORM E_SDN.DGN 02/2009

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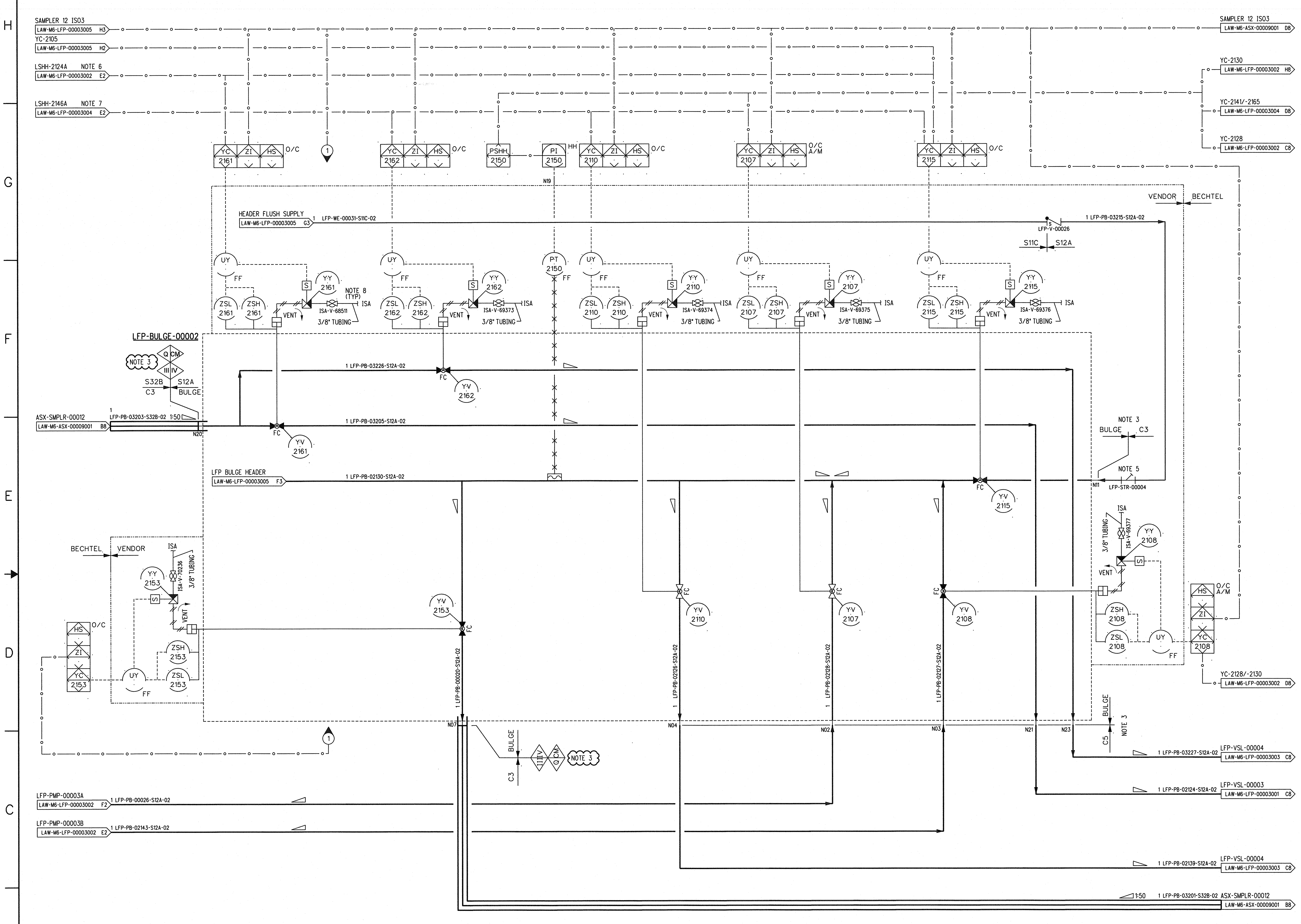

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. FOR DOUBLE CONTAINMENT PIPING OUTSIDE OF C5V VENTILATED ROOMS AND SECONDARY CONFINEMENT, THE PRESSURE BOUNDARY (OUTER ENCASEMENT ONLY) IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III. ALL OTHER COMPONENTS SHOWN ON THIS DRAWING ARE QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES ON SHOWN THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. POSITION STRAINER (WITHOUT STRAINER INTERNALS) WITH THE STRAINER PORT IN THE UP POSITION TO ALLOW FOR LINE CLEANING.
6. ICN INTERLOCK ON LFP-VSL-00003 LEVEL HI HI WILL CLOSE VALVES YV-2161, YV-2115, AND STOP PUMPS. STOPPING PUMPS LFP-PMP-00003A/B ISOLATES DISCHARGE VALVES YV-2107/-2108.
7. ICN INTERLOCK ON LFP-VSL-00004 LEVEL HI HI WILL CLOSE VALVES YV-2162, YV-2110, AND YV-2115.
8. SEE 24590-LAW-M6-LFP-00003005 FOR ISA SUPPLY.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LFP-00003, REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LFP-00035.
10. REVISION 1: INCORPORATED AND FURTHER REVISED 24590-LAW-M6N-LFP-00044, -00050, 24590-LAW-M6N-M80T-00016, AND -00085. INCORPORATED 24590-LAW-EIE-NS-17-0001 (REV 0). UPDATED OFF SHEET CONNECTOR, ADR REVISION NUMBER ON THE TITLE BLOCK, AND REFERENCE 1. ADDED QUALITY/SEISMIC FLAGS. REVISED QUALITY DESIGNATOR OF THIS DRAWING FROM CM TO Q, NOTES 6 AND 7. ADDED NOTE CALLOUTS. UPDATED OFF SHEET CONNECTOR.
11. REVISION 2: INCORPORATED CHANGE DOCUMENT 24590-LAW-M6N-LFP-00063.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LFP-00001, LAW MELTER FEED PROCESS (LFP) AND CONCENTRATE RECEIPT PROCESS (LCP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 11	ZH	JM	N/A	CMN TRV	6/5/19
1	REVISED PER NOTE 10	NAS	JWS	WTD	CR/PS/JW	08/21/17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	RJR	NTJ	SK/SS	RS/TH	2/16/11

REVISION HISTORY

Issued by RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

	BY	DATE
ORIGINATOR	RIDER, ROBERT	2/16/11
CHECKER	JOHNSON, NGA T	2/16/11
APPROVER	STEVENS,R/HUGHES,T	2/16/11
REVIEWER	KRETZSCHMAR,S/SMITH,S	2/16/11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-01-004 REV: 4

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW LAW MELTER FEED PROCESS SYSTEM MELTER 2 FEED PREPARATION AND FEED LFP-BULGE-00002

SCALE: NONE
24590-LAW-M6-LFP-00003006
REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED
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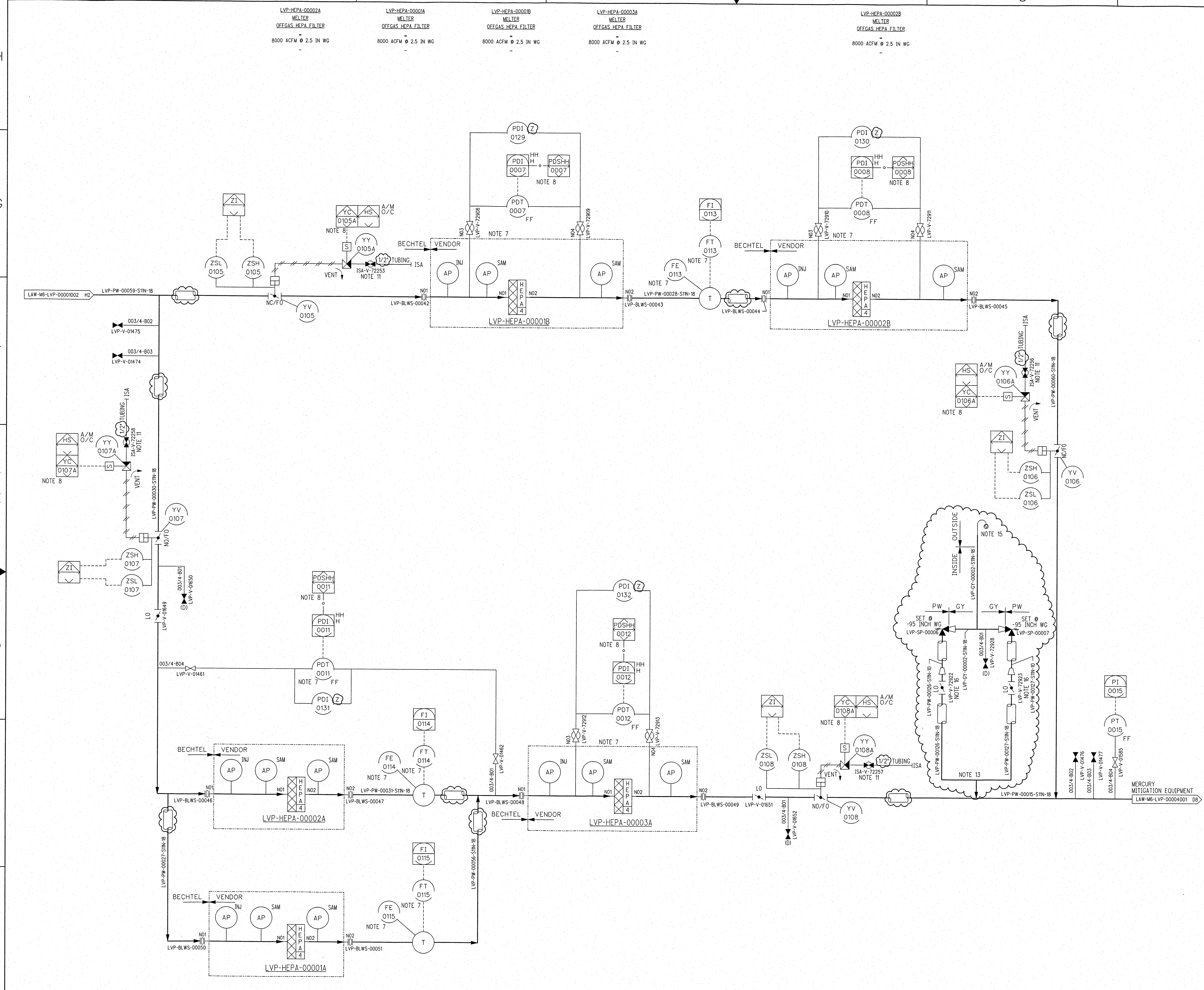
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. DELETED.
6. ABBREVIATIONS: INJ = INJECTION, SAM = SAMPLE.
7. THIS INSTRUMENT PERFORMS AN AIR PERMIT FUNCTION. INDICATION IS DISPLAYED AT PCJ.
8. IN THE EVENT OF A HI HI DIFFERENTIAL PRESSURE SIGNAL FROM A HEPA FILTER, MELTER FEED WILL BE TERMINATED AND THE OPERATOR WILL BE ALERTED. THE ALARMED FILTER TRAIN CAN THEN BE MANUALLY ISOLATED TO CORRECT THE PROBLEM. FAILURE TO OPEN THE ALTERNATE TRAIN WILL RESULT IN THE INABILITY TO ISOLATE THE FAULTY TRAIN.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART SUPERSEDES 24590-LAW-M6-LVP-00001 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00018, -00043, -00063, AND -00071. THIS DRAWING ADDS ADDITIONAL PURGE INSTRUMENTATION (FI-0168/0169/0170/0171) TO PRESSURE SENSING LINES.
10. FOR LVP-HEPA-00001A/B, 00002A/B, AND -00003A, HOUSINGS AND DUCTWORK SHOWN INSIDE VENDOR BOUNDARY LINES ARE DESIGNED AND TESTED PER ASME AG-1. TEST BOUNDARY FOR INPLACE PRESSURE LEAK TESTING OF HEPA 1B & 2B INCLUDING FLANGED CONNECTION TO INTERCONNECTING PIPING BY UTILIZING VALVES LVP-YV-0105 AND LVP-YV-0106. TEST BOUNDARY FOR INPLACE PRESSURE LEAK TESTING HEPA 1A, 2A, & 3A INCLUDING FLANGED CONNECTION TO INTERCONNECTING PIPING BY UTILIZING ISOLATION VALVES LVP-V-01649 AND LVP-V-01651.
11. IN-USE HEPA TRAIN SHALL HAVE ISA VALVE LOCKED CLOSED TO MAINTAIN OPEN OFFGAS PATH.
12. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00112, -00114, 24590-WTP-FC-M-16-0002, 24590-LAW-M6N-M80T-00016, -00033, AND INFORMATION FROM 24590-LAW-EIE-NS-17-0001, REV 0. REVISED HEPA INTERLOCK CONTROL STRATEGY, NOTE 8 AND REFERENCE 1. ADDED HEPA PDT ISOLATION VALVES AND NOTE 11. DELETED NOTE 5.
13. PRESSURE DROP IS TO BE MINIMIZED.
14. DELETED
15. THE QUALITY LEVEL OF THE OUTSIDE BIRD SCREEN MESH MAY BE CM.
16. LVP-V-72922 AND -72923 (STOCK CODE PVVFUC109P06 ARE PIPE CLASS N11F AND ACCEPTABLE FOR USE AS DISCUSSED IN 24590-WTP-NCR-MGT-10-0251, DISPOSITION #445.
17. REVISION 2: INCORPORATED 24590-LAW-M6N-LVP-00164, AND 24590-WTP-FC-IN-18-0042. INCORPORATED 24590-LAW-M6N-LVP-00168 AND FURTHER REVISED. ADDED DRAIN VALVE LVP-V-72928 TO VACUUM RELIEF ASSEMBLY. ADDED INSULATION SYMBOLS, NOTES 15, AND 16. UPDATED ADR REVISION.

HOLD OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS (LOP) AND SECONDARY OFFGAS/VESSEL VENT (LVP) SYSTEM DESIGN DESCRIPTION.

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 17	AF	CNK	KRS	TRV	5/14/19
1	REVISED PER NOTE 12	JW	NK	N/A	WJ/WW	07/27/17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	MO	SJ	SS	TH/DM	11/22/11

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11/18/11
CHECKER	JAIN, SATISH	11/18/11
APPROVER	HUGHES, T/MILDON, D	11/22/11
REVIEWER	SCHMUDE, STEVEN	11/18/11

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW LAW SECONDARY OFFGAS/ VESSEL VENT PROCESS SYSTEM HEPA FILTERS

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

SCALE: NONE

24590-LAW-M6-LVP-00001003 REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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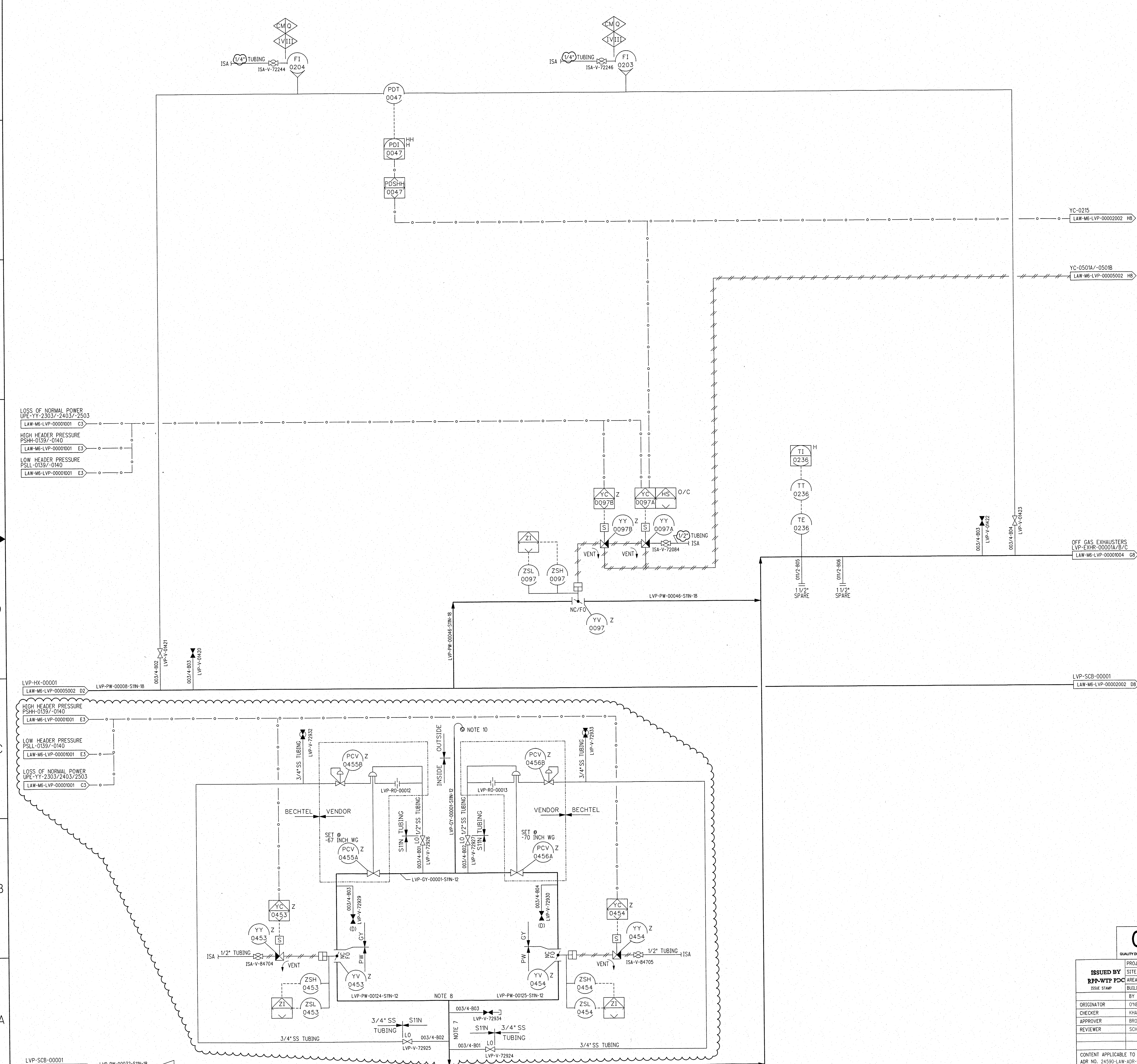
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART SUPERSEDES 24590-LAW-M6-LVP-00002 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00018, AND -00064.
6. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00118, -00140, 24590-LAW-M6N-M80T-00033, AND INFORMATION FROM 24590-LAW-EIE-NS-17-0001, REV 0. ADDED PNEUMATIC INSTRUMENT LINE. REVISED REFERENCES AND CONTROL STRATEGY.
7. PCV CONTROL LINES TO BE CONNECTED TO A STRAIGHT RUN OF PIPE 3 TO 5 PIPE DIAMETERS DOWNSTREAM OF THE NEAREST FLOW DISTURBANCE (E.G., TEE, ELBOW).
8. PRESSURE DROP IS TO BE MINIMIZED.
9. DELETED
10. THE QUALITY LEVEL OF THE OUTSIDE BIRD SCREEN MESH MAY BE CM.
11. THE INLET PCV PIPE SHALL BE AT LEAST 4 PIPE DIAMETERS IN LENGTH OF STRAIGHT PIPE IMMEDIATELY UPSTREAM OF THE 12" PCV. THE UPSTREAM SENSING LINE CONNECTION CAN BE CONNECTED ANY PLACE ON THE INLET PIPE OF THE 12" PCV. THE DOWNSTREAM SENSING LINE CONNECTION SHALL BE LOCATED AFTER A STRAIGHT PIPE LENGTH OF AT LEAST 10 PIPE DIAMETERS TO OBTAIN A PRESSURE READING IN A LAMINAR FLOW SECTION. THIS PIPE LENGTH SECTION DOES NOT NEED TO BE IMMEDIATELY DOWNSTREAM OF THE PCV. REQUIREMENTS FROM VENDOR ARE NOTED IN REFERENCE 2.
12. REVISION 2: INCORPORATED 24590-WTP-FC-IN-18-0042. INCORPORATED 24590-LAW-M6N-LVP-00168 AND FURTHER REVISED. DRAIN VALVES LVP-V-72929 AND LVP-V-72930, AND INSIDE/OUTSIDE BREAK WERE ADDED TO VACUUM RELIEF ASSEMBLY. ADDED THREE TEST PORTS TO VACUUM RELIEF ASSEMBLY IN RESPONSE TO 24590-LAW-CPAF-PENG-19-0005. ADDED NOTE 10, 12, VENDOR/BECHTEL BOUNDARY LINE, AND REFERENCE 2. UPDATED ADR REVISION.

HOLD OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS (LOP) AND SECONDARY OFFGAS/VESSEL VENT (LVP) SYSTEM DESIGN DESCRIPTION.
2. 24590-QL-POA-JV05-00004-07-00001 REV 00B, DRAWING-TYPE 1098-EGR SIZE 12X6 CL 150R F 1098 SIZE 70 W/ Y690VB PRESSURE REDUCING REGULATOR.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LVP-00002001	LVP SYSTEM CAUSTIC SCRUBBER BYPASS
24590-LAW-M6-LVP-00002002	LVP SYSTEM CAUSTIC SCRUBBER
24590-LAW-M6-LVP-00002003	LVP SYSTEM CAUSTIC COLLECTION TANK
24590-LAW-M6-LVP-00002004	LVP SYSTEM RECIRCULATION LOOP
24590-LAW-M6-LVP-00002005	LVP SYSTEM TRANFER PUMPS
24590-LAW-M6-LVP-00002006	LVP SYSTEM STACK MONITORING
24590-LAW-M6-LVP-00002007	LVP SYSTEM STACK DISCHARGE MONITORING SYSTEM

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 12	OF	CNK	KDS		5/14/19
1	REVISED PER NOTE 6	JS	MO	NC	BJ/WJ	07-27-17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 5	MO	JK	SS	MB/DM	11-30-11

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590	
SITE	HANFORD	
AREA	200E	
BUILDING No.	20	

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11-30-11
CHECKER	KHANDHAR, JAYANT	11-30-11
APPROVER	BROWN, M / MILDON, D	11-30-11
REVIEWER	SCHMUDE, STEVEN	11-30-11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW SECONDARY OFFGAS/ VESSEL VENT PROCESS SYSTEM CAUSTIC SCRUBBER BYPASS

SCALE: NONE

24590-LAW-M6-LVP-00002001 REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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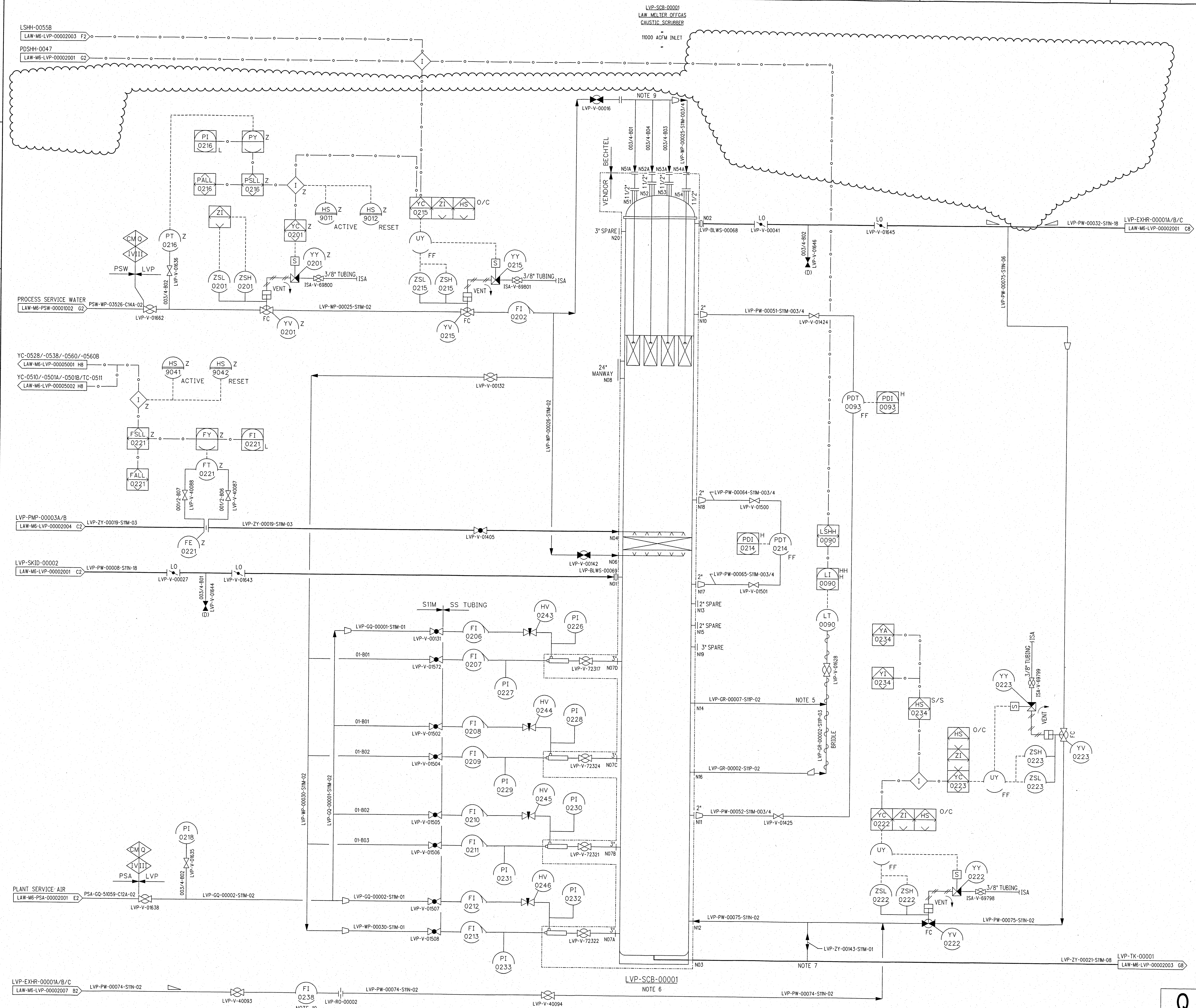
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. LIMIT BRIDLE ORIFICE CONNECTION TO 3/8 INCHES OD.
6. ACCESSIBLE AREAS OF EQUIPMENT SHALL HAVE 4 1/2 INCHES OF INSULATION FOR PERSONNEL PROTECTION OR HAVE GUARDS, BARRIERS, AND OR SHIELDS WHERE INSULATION IS NOT FEASIBLE OR APPROPRIATE.
7. ATTACHMENT BEFORE FIRST VERTICAL DROP OF LVP-ZY-00021-S11M-08 AND DOWNSTREAM OF NOZZLE N03.
8. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART SUPERSEDES 24590-LAW-M6-LVP-00002 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00018, -00038, -00042, -00045, -00051, -00062, -00064, -00067, AND -00075. PLANT SERVICE AIR SAFETY INTERLOCKS DELETED.
9. REMOVABLE SPOOL TO ALLOW REMOVAL/REPLACEMENT OF VENDOR SUPPLIED DEMISTER SPRAY NOZZLES.
10. FLOW INSTRUMENT INDICATES FLOW/NO-FLOW.
11. DELETED
12. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00092, -00096, -00135, -00143, 24590-QL-MRA-MKAS-00003-T0011, 24590-WTP-FC-P-14-0037 AND 24590-LAW-EIE-NS-17-0001 (REV 0). ADDED VACUUM BREAKER DESIGN, OFF SHEET CONNECTORS AND NOTE 11. REVISED REFERENCE 1 AND SAFETY CONTROLS.
13. DELETED
14. REVISION 2: INCORPORATED 24590-LAW-M6N-LVP-00168. UPDATED ADR REVISION.

HOLD OPEN ITEMS:

1. DELETED

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS (LOP) AND SECONDARY OFFGAS/VESSEL VENT (LVP) SYSTEM DESIGN DESCRIPTION.

LVP-TK-00001
LAW-M6-LVP-00002003 G8

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 14	CJF	CNK	KDS	TRV	5/14/19
1	REVISED PER NOTE 12	JWS	MRO	NK	CL/PS/JW	08/09/17
0	ISSUED FOR CONSTRUCTION, SEE NOTE 8	MO	JK	SS	MB/DM	11-30-11

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11-30-11
CHECKER	KHANDHAR, JAYANT	11-30-11
APPROVER	BROWN, M / MILDON, D	11-30-11
REVIEWER	SCHMUDE, STEVEN	11-30-11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW SECONDARY OFFGAS/ VESSEL VENT PROCESS SYSTEM CAUSTIC SCRUBBER LVP-SCB-00001

SCALE: NONE

24590-LAW-M6-LVP-00002002 REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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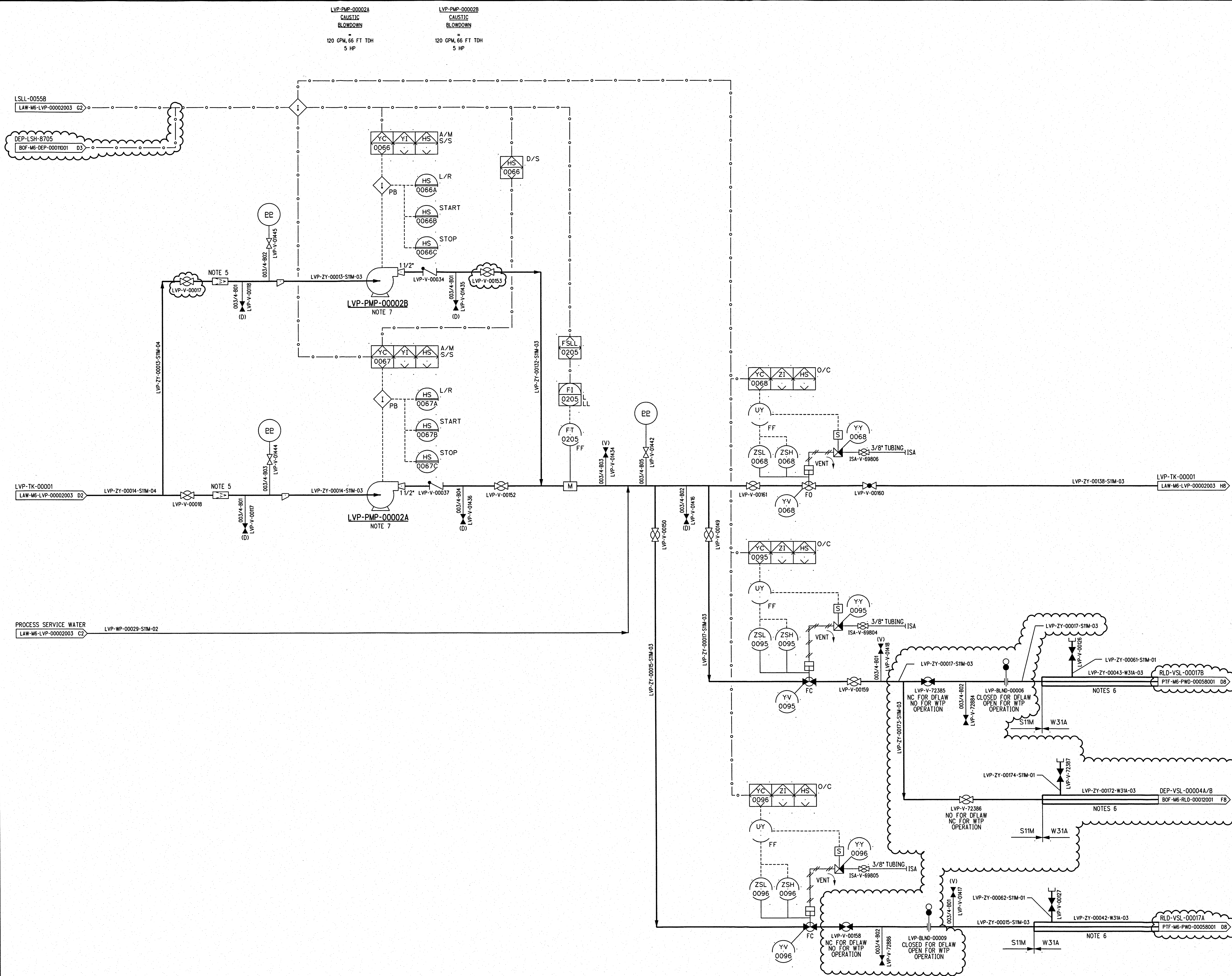

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. PROVIDE A REMOVABLE SPOOL PIECE FOR STARTUP STRAINER.
6. THERE SHALL BE NO POCKETS IN THE LINE WITHIN LAW AND PAST HOSE CONNECTIONS TO PRETREATMENT. MINIMUM SLOPE AS REQUIRED BY PERMIT P&ID 24590-PTF-M6-PWD-P0058.
7. ACCESSIBLE AREAS OF EQUIPMENT SHALL HAVE 1 1/2 INCHES OF INSULATION FOR PERSONNEL PROTECTION OR HAVE GUARDS, BARRIERS, AND OR SHIELDS WHERE INSULATION IS NOT FEASIBLE OR APPROPRIATE.
8. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART SUPERSEDES 24590-LAW-M6-LVP-00002 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00038, -00062, AND -00064.
9. THIS REVISION INCORPORATES 24590-LAW-M6N-LVP-00122, -00138, 24590-WTP-M6N-J2IT-00001, 24590-BOF-EIE-J-19-0003, REVISION 0, 24590-BOF-EIE-J-19-0006, REVISION 0, 24590-BOF-EIE-M-15-0123, REVISION 0, 24590-BOF-EIE-MS-17-0021, REVISION 0, AND 24590-WTP-EIE-SYSE-16-0082, REVISION 0. UPDATED REFERENCES.

HOLD OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS (LOP) AND SECONDARY OFFGAS/VESSEL VENT (LVP) SYSTEMS.
2. 24590-LAW-ADR-M-02-023 REV 5, LAW SECONDARY OFFGAS VESSEL VENT PROCESS SYSTEM (LVP).
3. 24590-WTP-ADR-M-16-0001 REV 4, ALARA DESIGN REVIEW FOR BOF DEP SYSTEM.

PLEASE NOTE THAT SOURCE, SPECIAL NUCLEAR AND BYPRODUCT MATERIALS, AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954 (AEA) ARE REGULATED AT THE U.S. DEPARTMENT OF ENERGY (DOE) FACILITIES EXCLUSIVELY BY DOE ACTING PURSUANT TO ITS AEA AUTHORITY DOE ASSERTS, THAT PURSUANT TO THE AEA IT HAS SOLE AND EXCLUSIVE RESPONSIBILITY AND AUTHORITY TO REGULATE SOURCE, SPECIAL NUCLEAR AND BYPRODUCT MATERIALS AT DOE-OWNED NUCLEAR FACILITIES. INFORMATION CONTAINED HEREIN ON RADIONUCLIDES IS PROVIDED FOR PROCESS DESCRIPTION PURPOSES ONLY.

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 9	LH	BVM	N/A	MTP	5/30/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 8	MO	JK	SS	DM/MB	11/3011

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	O'NEIL, MICHAEL	11/30/11
CHECKER	KHANDAR, JAYANT	11/30/11
APPROVER	BROWN, M/MILDON, D	11/30/11
REVIEWER	SCHMUDE, STEVEN	11/30/11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO: SEE REFERENCES 2 AND 3 REV:

P&ID - LAW
LAW SECONDARY OFFGAS/ VESSEL VENT PROCESS SYSTEM TRANSFER PUMPS LVP-PMP-00002A/B

SCALE: NONE
24590-LAW-M6-LVP-00002005
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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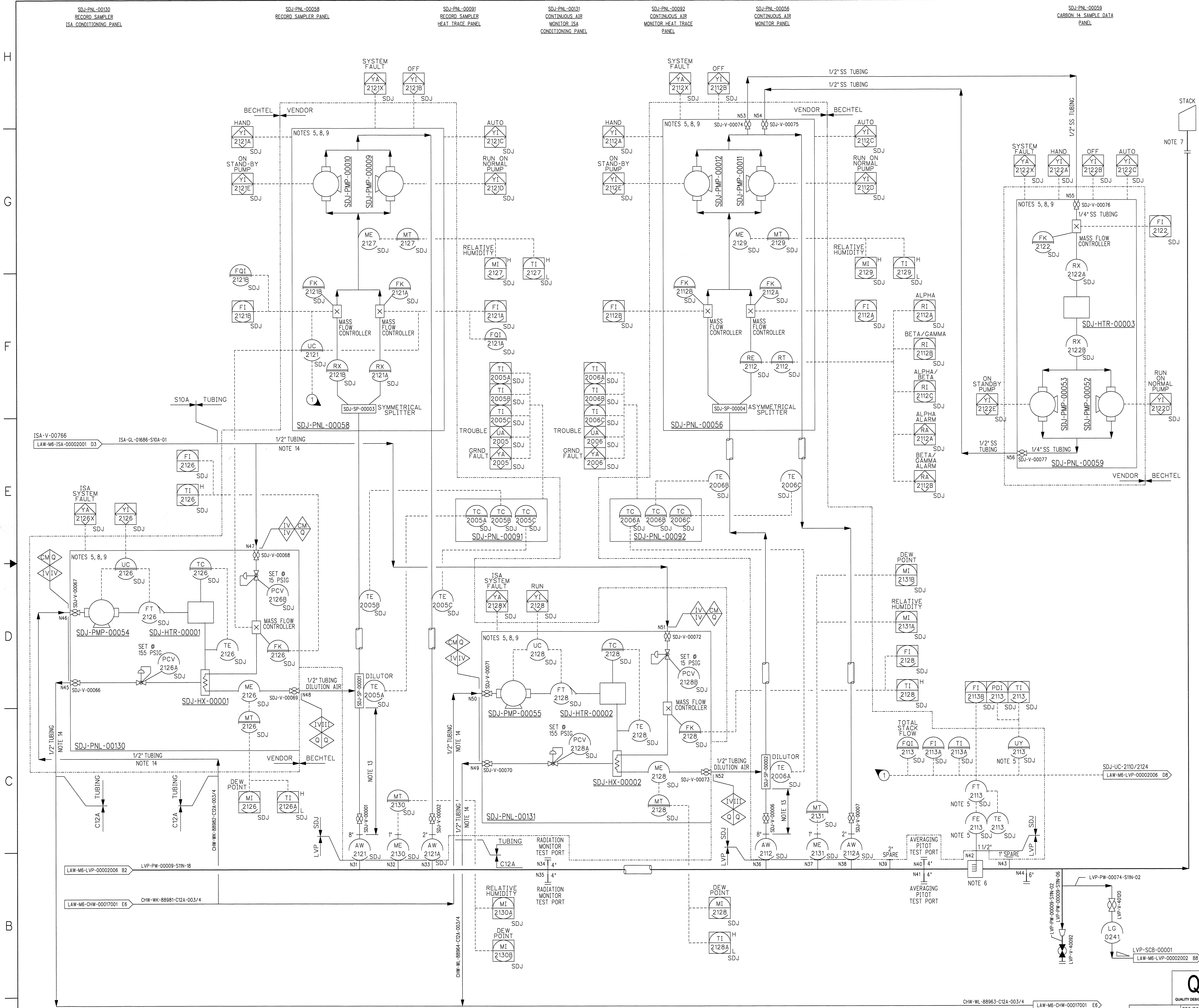


NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. PERFORMS AN AIR PERMIT FUNCTION. INSTRUMENT INDICATION DISPLAYED AT PCJ.
6. DRILLED HOLE FOR PITOT ELEMENT SHALL BE 1 INCH NOMINAL AND FLANGE SIZE SHALL BE 1 1/2 INCH.
7. INSULATION SHALL TERMINATE APPROXIMATELY 7 FEET ABOVE ROOF ELEVATION.
8. EQUIPMENT SHALL BE SUPPLIED WITH VALVE(S) FOR TRANSPORT SYSTEM PURGING AND/OR FOR CALIBRATION CHECKS OF MASS FLOW CONTROLLER(S).
9. FINAL DETAIL DESIGN TO BE PROVIDED BY 24590-QL-MRA-JA03-00001 VENDOR PACKAGE.
10. DELETED.
11. DELETED.
12. THIS DRAWING DEPICTS PORTIONS OF THE SYSTEM THAT WERE TRANSFERRED FROM 24590-LAW-M6-LVP-00002006 REV 0. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00082, -00090, -00098. ADDED DETAILS OF SDJ SYSTEM.
13. THIS SECTION OF TUBING IS TO REMAIN UNINSULATED AND PER THERMAL INSULATION GUIDE 24590-WTP-GPG-M-021 IS CLASSIFIED AS "PG", ADJUSTABLE TO EQUIPMENT REQUIRING MAINTENANCE.
14. SPECIFIC TUBING INSIDE VENDOR BOX IS BECHTEL SUPPLIED.
15. REVISION 1: MAJOR REVISION, NO REVISION CLOUDS REQUIRED. INCORPORATED 24590-LAW-M6N-LVP-00119. ADDED NOTES 13, 14 & 15, REDUCERS, LINE TAG NUMBERS, AND OFF SHEET CONNECTORS. THIS DRAWING DEPICTS VENDOR DOCUMENT SUBMITTED CHANGES IN DESIGN AND THE ADDITION OF THE REQUIRED ATOMIC ENERGY ACT STAMP.

HOLD OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3YD-LOP-00001, SYSTEM DESCRIPTION FOR THE LAW PRIMARY OFFGAS (LOP) AND SECONDARY OFFGAS/VESSEL VENT (LVP) SYSTEMS.

NOZZLE SCHEDULE

NOZZLE NUMBER	FLANGE SIZE	NOZZLE DESCRIPTION
N31	8"	RECORD SAMPLER SAMPLE PORT
N32	1"	RECORD SAMPLER MOISTURE ANALYZER
N33	2"	RECORD SAMPLER RETURN
N34	4"	RADIATION MONITOR TEST PORT
N35	4"	RADIATION MONITOR TEST PORT
N36	8"	CAM SAMPLE PORT
N37	1"	CAM MOISTURE ANALYZER
N38	2"	CAM SAMPLE RETURN
N39	2"	SPARE
N40	4"	AVERAGING PITOT TEST PORT
N41	4"	AVERAGING PITOT TEST PORT
N42	1.5"	AVERAGING PITOT PORT
N43	1"	SPARE
N44	6"	SIX INCH PORT
N45	1/2"	SDJ-PNL-00130 CHW OUT
N46	1/2"	SDJ-PNL-00130 CHW IN
N47	1/2"	SDJ-PNL-00130 ISA IN
N48	1/2"	SDJ-PNL-00130 DILUTION AIR OUT
N49	1/2"	SDJ-PNL-00131 CHW OUT
N50	1/2"	SDJ-PNL-00131 CHW IN
N51	1/2"	SDJ-PNL-00131 ISA IN
N52	1/2"	SDJ-PNL-00131 DILUTION AIR OUT
N53	1/2"	SDJ-PNL-00056 SAMPLE OUT
N54	1/2"	SDJ-PNL-00056 SAMPLE RETURN
N55	1/2"	SDJ-PNL-00059 SAMPLE IN
N56	1/2"	SDJ-PNL-00059 SAMPLE OUT

Q
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 15	JMB	MAO			3/30/16
0	ISSUED FOR CONSTRUCTION, SEE NOTE 12	MO	RP	SA/JK	PO/KH	01/27/14

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

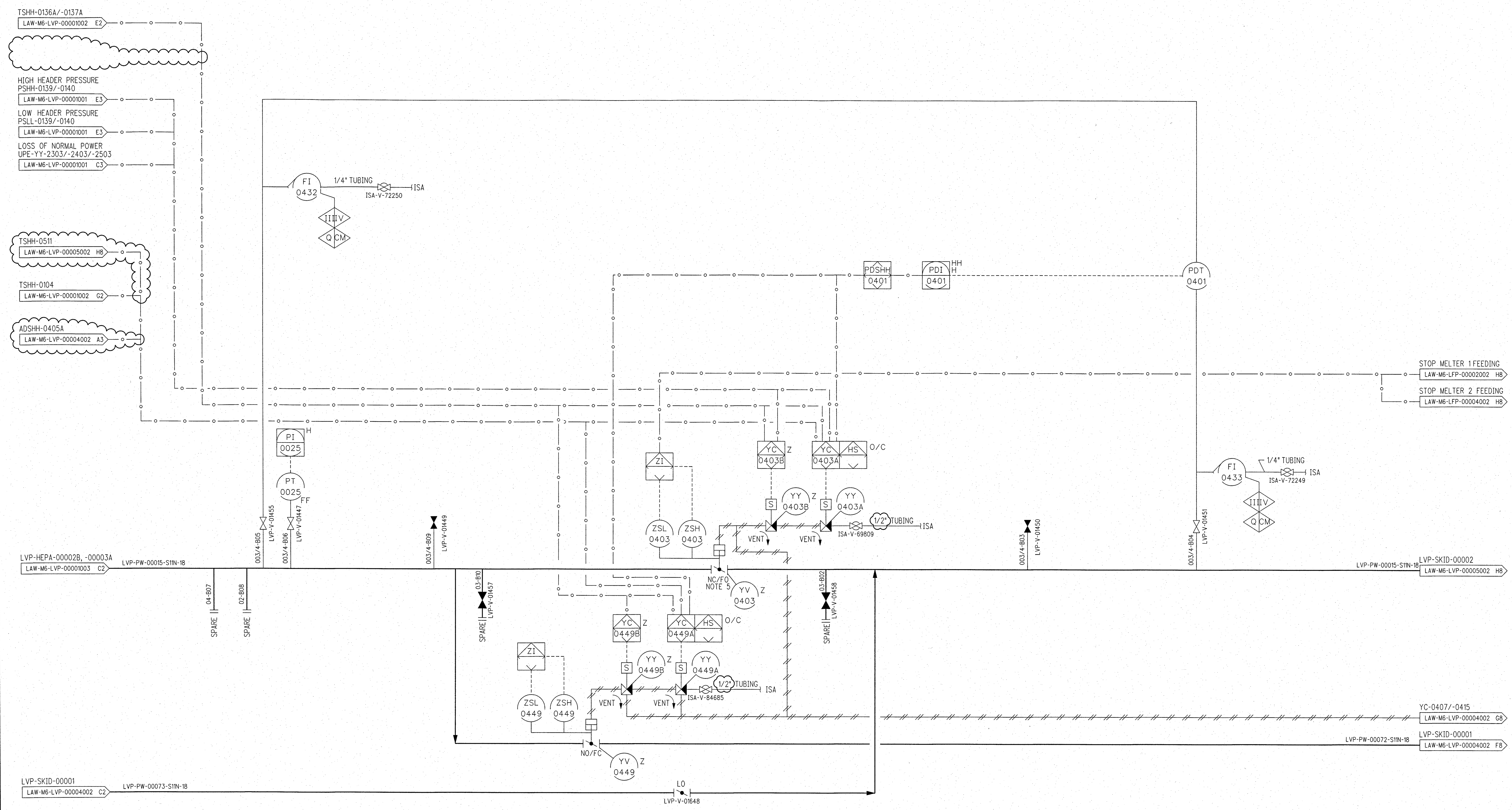
CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	01/24/14
CHECKER	PETERS, RICHARD D	01/24/14
APPROVER	HUBER, KEITH A	01/27/14
REVIEWER	AUSTEN, B/KULBECK, J	01/27/14

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 4

P&ID - LAW
LAW SECONDARY OFFGAS/ VESSEL VENT PROCESS SYSTEM STACK DISCHARGE MONITORING SYSTEM

SCALE: NONE
24590-LAW-M6-LVP-00002007
REV 1



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. THE BYPASS VALVE, YV-0403 SHALL OPEN FIRST BEFORE CLOSING THE INLET ISOLATION VALVES.
6. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND IN PART SUPERSEDES 24590-LAW-M6-LVP-00004 REV 2. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00018, AND -00065.
7. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00084, -00089, -00115 AND -00125. ADDED/REVISED/DELETED NOTES, VALVES, TUBING SIZES, QUALITY BREAKS, AND INSTRUMENTS.
8. REVISION 2: INCORPORATED INFORMATION FROM 24590-LAW-EIE-NS-17-0001, REV 0. REVISED REFERENCE 1, INTERLOCK CONTROL STRATEGY, AND NOTE 5. ADDED REDUNDANT INLET ISOLATION VALVE.
9. REVISION 3: INCORPORATED 24590-WTP-FC-IN-18-0042 AND CCN 308167.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS PROCESS (LOP) AND LAW SECONDARY OFFGAS/VESSEL VENT PROCESS (LVP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX	
DWG NO	TITLE
24590-LAW-M6-LVP-00004001	LVP SYS Hg MITIGATION EQUIPMENT BYPASS
24590-LAW-M6-LVP-00004002	LVP SYS Hg MITIGATION EQUIP LVP-SKID-00001
24590-LAW-M6-LVP-00004003	LVP SYS Hg MITIGATION EQIP LVP-ADBR-00001A/B

Originator By: J. ECKEL - ajeckel Org Name: BNI Placed: Jul 24, 2019
Checked By: Tyler Maki - tjmaki Org Name: Mechanical Systems Placed: Jul 24, 2019

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
3	REVISED PER NOTE 9			N/A	AML CMW TRV	8/19/19
2	REVISED PER NOTE 8	JWS	NK	N/A	JS/WJ/JW	07/27/17
1	REVISED PER NOTE 7	DMH	MRO	BA/JK	SK/JK	11/17/14
0	ISSUED FOR CONSTRUCTION, SEE NOTE 6	MO	SJ	SS	TH/DM	11-22-11

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

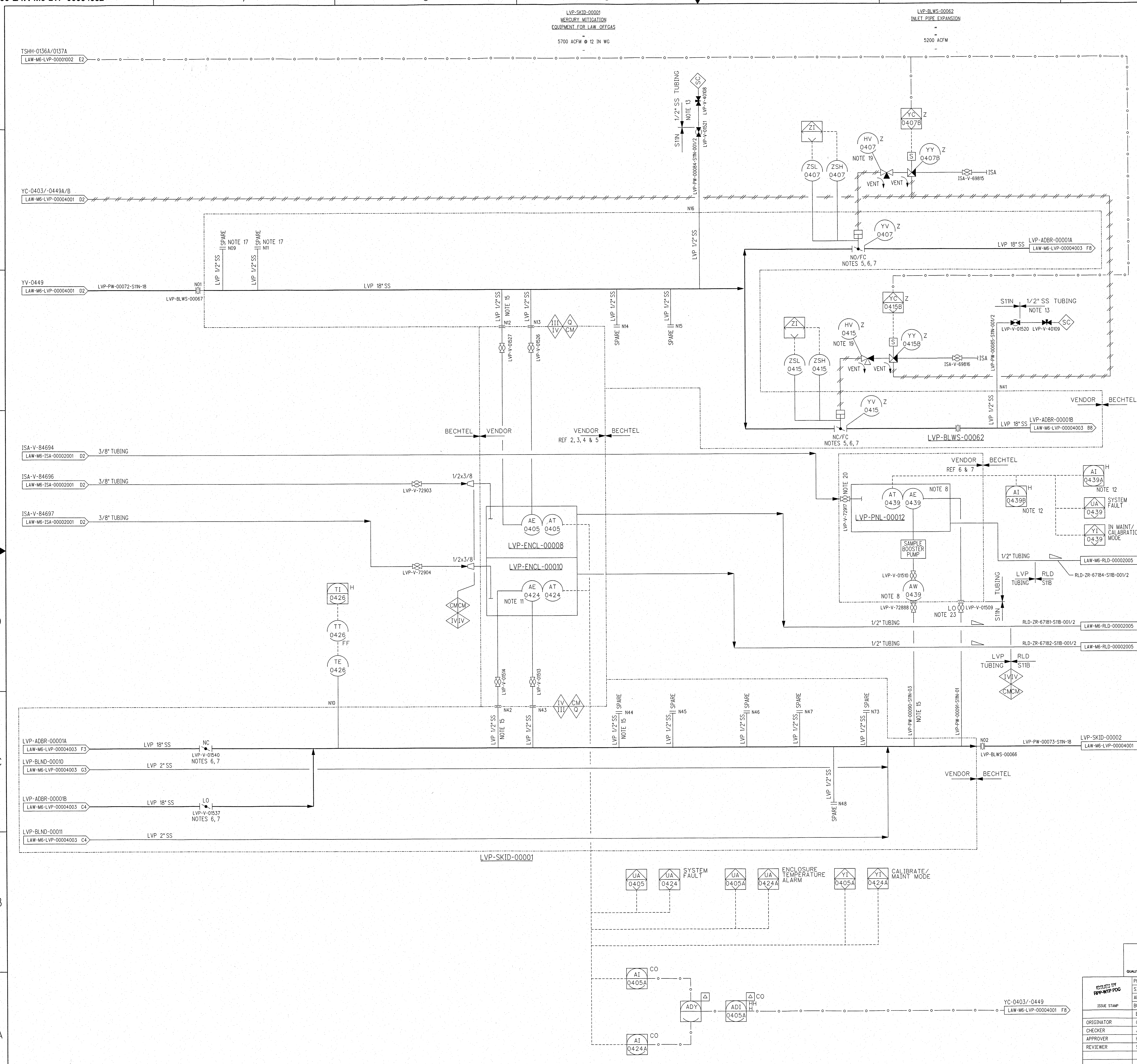
CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11-18-11
CHECKER	JAIN, SATISH	11-18-11
APPROVER	BROWN, M / MILDON, D	11-22-11
REVIEWER	SCHMUDE, STEVEN	11-18-11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

P&ID - LAW
LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM MERCURY MITIGATION EQUIPMENT BYPASS

SCALE: NONE
24590-LAW-M6-LVP-00004001
REV 3



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. CARBON ADSORBER ISOLATION VALVES YV-0407 AND YV-0415, SHALL MEET LEAKAGE REQUIREMENTS AS STATED IN THE PDSA.
6. ADSORBERS ARE NORMALLY RUN IN LEAD/LAG MODE, BUTTERFLY VALVES ARE SHOWN NO/NC (OR LO) FOR LVP-ADBR-00001A IN LEAD MODE, VALVES WOULD BE REVERSED TO PUT LVP-ADBR-00001B INTO LEAD MODE. AT LEAST ONE CONTINUOUS FLOW PATH SHALL HAVE VALVES IN OPEN POSITION (OR LO FOR LVP-V-01537/-01540) TO PREVENT BLOCKING OFFGAS SYSTEM DURING OPERATION.
7. SUPPLIED BY BECHTEL.
8. THIS INSTRUMENT PERFORMS AN AIR PERMIT FUNCTION. INDICATION IS DISPLAYED AT PCJ.
9. DELETED
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LVP-00004 REV 2. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-000046, -00052, -00053, -00055, -00065, AND -00068. ADDED/REVISED/DELETED VALVES, INSTRUMENTS AND LINE NUMBERS.
11. INSTRUMENTS AE-0405 AND -0424 MEASURE CO LEVELS.
12. INSTRUMENT AI-0439A INDICATES HF LEVELS AND INSTRUMENT AI-0439B INDICATES HCL LEVELS.
13. CONSTRUCTION SHALL FIELD ROUTE TUBING FROM ISOLATION VALVE TO SAMPLE CONNECTION. SEE DRAWING 24590-WTP-M0-50-00072 (FUTURE) FOR ROUTING DETAILS.
14. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00091, -00101, AND -00107. ADDED/REVISED/DELETED VALVES, INSTRUMENTS, EQUIPMENT, IN-LINE COMPONENTS, NOTES AND HOLD. THIS DRAWING ALSO INCLUDED CHANGES TO ALIGN THE BECHTEL P&IDS WITH THE VENDOR P&IDS.
15. SAMPLE EXTRACTION NOZZLES EXTEND INTO MAIN PROCESS LINE IN ORDER TO OBTAIN REPRESENTATIVE SAMPLE.
16. DELETED
17. LVP-TW-0404 AND LVP-TW-0434 ARE USED AS 1/2" SPARE AT N09 AND N11 RESPECTIVELY.
18. REVISION 2: INCORPORATED 24590-LAW-M6N-LVP-00136, 24590-WTP-SDDR-J-14-00112, AND 24590-WTP-SDDR-J-15-00068. DELETED TAGS FOR LVP-TW-0404, -0434 (TT-0404/0434, TE-0404/0434, TY/TI-0404/0434, TAHH-0404/0434, TSHH-0404/0434), NOZZLES N56, N57, 3/8" TUBING, NOTE 9 AND REMOVED HOLD NOTE. ADDED NOTE CALLOUT, TAGS FOR LVP-ENCL-00008, -00009, -00010, -00011, LVP-PNL-00012, LVP-TW-0136, -0137 (TAHH-0136B/0137B AND TSHH-0136B/0137B). RELOCATED VENDOR/BECHTEL BOUNDARY FOR LVP-V-01509 AND FOR THE CONNECTION OF LVP-SKID-00001 TO LVP-PW-00090/-00091. THIS DRAWING REVISION SUPERSEDED VENDOR DRAWING, 24590-QL-POA-MWK0-00001-05-00070, REV 00R.
19. MANUAL 3-WAY BALL VALVES ARE LOCKABLE.
20. SYSTEM BREAK FROM ISA TO LVP IS AT THE ISOLATION VALVE INLET. UPSTREAM OF THIS VALVE, THE LINES ARE CM AND SC IV. DOWNSTREAM THE LINES ARE Q AND SC III.
21. REVISION 3: REMOVED TSHH-0136B/0137B (PREHEATER OUTLET) AND THEIR INTERLOCK. REVISED YV-0407/-0415 CONTROLS, NOTES 5, 11 AND 12. ADDED NEW NOTES 19 AND 20, ISA AND RLD DRAIN LINES TO THE LVP ENCLOSURES AND PANELS. REMOVED YV-0449/0450 ON THE OUTLET OF LVP-SKID-00001 AND ADDED LOCKED-OPEN MANUAL ISOLATION VALVES IN THEIR PLACES. DELETED CO CONTROLS. REMOVED OFF-SHEET CONNECTORS TO STOP MELTER FEED AND DIW ADDITION. CHANGED CO PANEL INDICATORS INTERCONNECTION FROM ELECTRICAL TO INTERNAL SYSTEM LINKS. INCLUDES INFORMATION FROM 24590-LAW-EIE-NS-17-0001 (REV 0).
22. FOR SOME VENDOR SUPPLIED ITEMS, SEE ASSOCIATED VENDOR REFERENCES FOR DETAILS.
23. VALVE LOCKED OPEN DURING ANALYZER OPERATION. INADVERTANT CLOSURE MAY CAUSE EQUIPMENT DAMAGE.
24. REVISION 4: MAJOR REVISION, NO REVISION CLOUDS REQUIRED. INCORPORATED 24590-LAW-M6N-LVP-00160/-00165, 24590-WTP-SDDR-J-18-00014, AND CCN 308167. INCORPORATED 24590-LAW-EIE-MS-14-0007 REV 0 WITH NO IMPACT.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS PROCESS (LOP) AND LAW SECONDARY OFFGAS/VESSEL VENT PROCESS (LVP) SYSTEM DESIGN DESCRIPTION.
2. 24590-QL-POA-JA03-00008-08-00007 DRAWING - TDLS CO SYSTEM TUBING DETAIL.
3. 24590-QL-POA-JA03-00008-08-00008 DRAWING - TDLS CO SYSTEM MASTER TAG LIST.
4. 24590-QL-POA-JA03-00008-08-00001 DRAWING - TDLS CO SYSTEM CABINET LAYOUT.
5. 24590-QL-POA-JA03-00008-08-00002 DRAWING - TDLS CO SYSTEM CABINET LAYOUT.
6. 24590-CD-POA-JA03-00007-07-00019 DRAWING - ANALYZER LVP-AT-0439 LVP-PNL-00012 / SAMPLE SYSTEM TUBING SCHEMATIC DIAGRAM.
7. 24590-CD-POA-JA03-00007-07-00022 DRAWING - ANALYZER LVP-AT-0439 LVP-PNL-00012 / ANALYZER ENCLOSURE GENERAL ARRANGEMENT DRAWING (EXTERIOR).

Originator By: J. ECKEL - ajeckel Org Name: BNI Placed: Jul 24, 2019

Checked By: Tyler Maki - tjmaki Org Name: Mechanical Systems Placed: Jul 24, 2019

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
4	REVISED PER NOTE 24			N/A	TRV	8/19/19
3	REVISED PER NOTE 21	JWS	NK	N/A	WJ/JS/JW	7/27/17
2	REVISED PER NOTE 18	CTT	TJV	NK	PR/DY/JW	08/22/16
1	REVISED PER NOTE 14	DMH	MRO	BA/JK	SK/JW	11/17/14
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MO	SJ	SS	TH/DM	11/22/11

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11/18/11
CHECKER	JAIN, SATISH	11/18/11
APPROVER	HUGHES, T / MILDON, D	11/22/11
REVIEWER	SCHMUDE, STEVEN	11/18/11

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM MERCURY MITIGATION EQUIPMENT LVP-SKID-00001

SCALE: NONE

24590-LAW-M6-LVP-00004002 REV 4

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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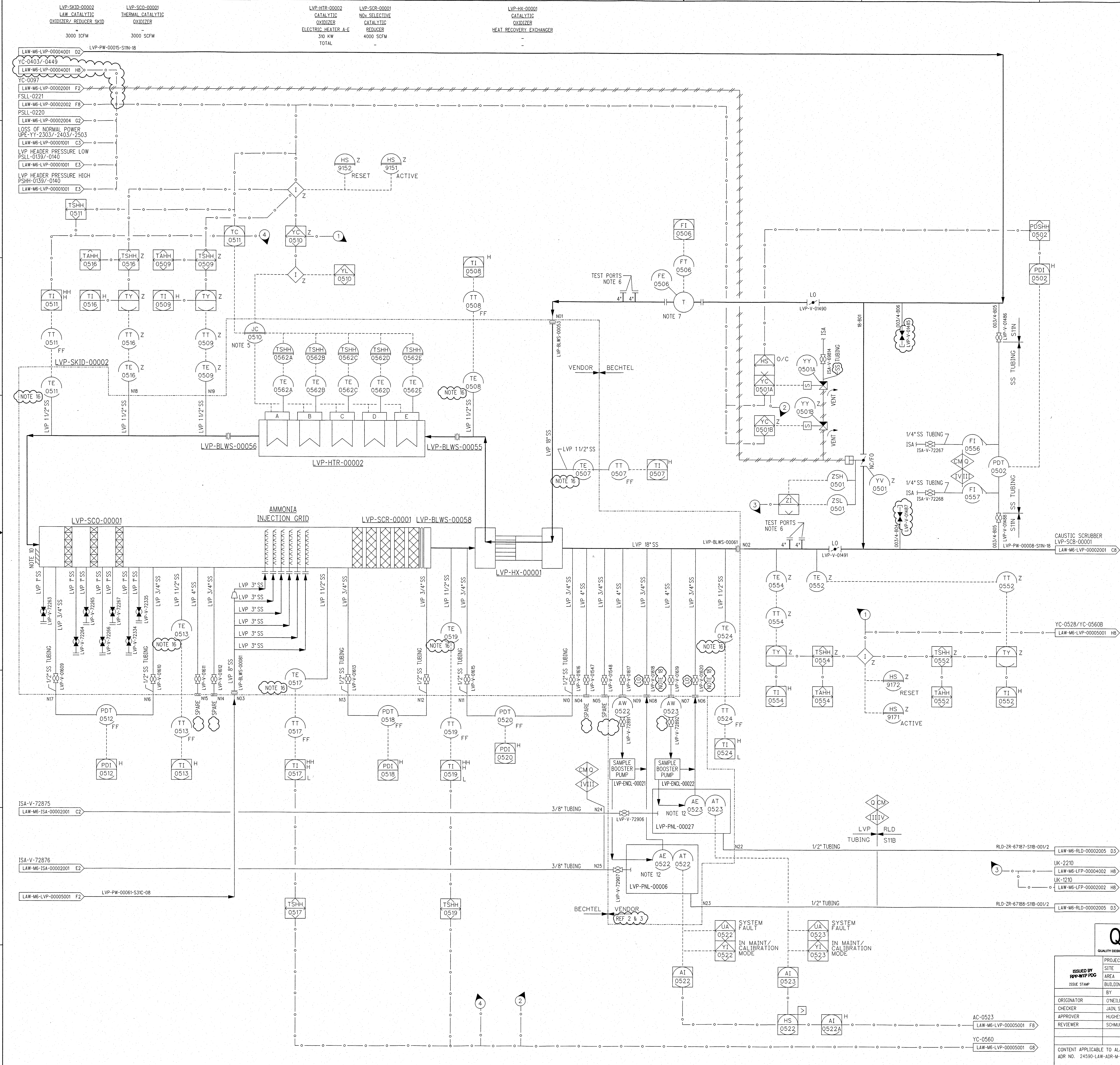

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL Q AND SEISMIC CATEGORY SC-III, UNLESS OTHERWISE NOTED.
4. DELETED
5. FIVE HEATER BANKS ARE CONTROLLED FROM ICN VIA VENDOR CONTROL PANEL LVP-PNL-00003.
6. TEST PORTS ARE TO BE INSTALLED AT THE SAME AXIAL POSITION. ONE PORT SHOULD BE AS CLOSE TO VERTICAL (TOP) AS POSSIBLE. THE OTHER SHOULD BE 90° OPPOSED. TEST PORTS SHALL BE PLACED A MINIMUM OF TWO (2) INSIDE PIPE DIAMETERS FROM UPSTREAM FLOW DISTURBANCES AND A MINIMUM OF ONE-HALF (1/2) INSIDE PIPE DIAMETER FROM DOWNSTREAM DISTURBANCES. WHERE PRACTICAL, THESE STRAIGHT RUN DISTANCES SHOULD BE DOUBLED.
7. FLOW ELEMENT SHALL BE LOCATED A MINIMUM OF TEN INSIDE PIPE DIAMETERS FROM UPSTREAM AND DOWNSTREAM FLOW DISTURBANCES TO ENSURE STRAIGHT PIPE FLOW DISTRIBUTION THROUGH THE DEVICE. TEST PORTS ARE NOT REGARDED TO CREATE FLOW DISTURBANCES.
8. JUNCTION BOX LVP-JB-00012 (NON-SAFETY) TO BE INSTALLED ON TCO SKID.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND IN PART SUPERSEDES 24590-LAW-M6-LVP-00005 REV 2. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LVP-00054, -00057, -00060, -000066, -00069, AND 24590-QL-MRA-MBT0-00007-T0003.
10. INSULATION PER 24590-WTP-SDDR-MS-14-00002.
11. REVISION 1: INCORPORATED 24590-LAW-M6N-LVP-00083, -00088, AND -00091. REVISED/ADDED VALVES, BELLOWS, NOZZLES, NOTES, AND INSTRUMENTATION.
12. INSTRUMENTS AE-0522 AND AE-0523 MEASURE NH3 LEVELS.
13. REVISION 2: INCORPORATED 24590-LAW-M6N-LVP-00074. REVISED/DELETED/ADDED NOTES, HOSES, CAP, VALVES, BELLOWS, LINE MATERIALS, VENDOR/BECHTEL BOUNDARY, FLANGES, AND INSTRUMENTATION.
14. REVISION 3: INCORPORATED 24590-LAW-M6N-LVP-00128 AND 24590-LAW-M6N-M80T-00033. DELETED INSTRUMENTS LVP-HS-0510, LVP-HA-0510, HIGH ALARM DESIGNATION ON LVP-AI-0522, LVP-AI-0523, PIPELINES LVP-PW-00115, -00116, -00117, -00118, VALVES LVP-V-72340 AND -72341. ADDED INSTRUMENT LVP-AI-0522A AND BELLOW LVP-BLWS-00081 TO PIPELINE LVP-PW-00061. REVISED BELLOWS LVP-BLWS-00055, -00056 AND -00058 FROM IN-LINE FITTINGS TO EQUIPMENT, INSTRUMENT LINE BETWEEN LVP-YC-0510 AND INTERLOCK FROM ELECTRICAL SIGNAL TO DATA LINK, EQUIPMENT DESCRIPTION FOR LVP-HX-00001 FROM HEAT RECOVERY UNIT TO HEAT RECOVERY EXCHANGER AND VENDOR BOUNDARY FOR ANALYZER ENCLOSURES. UPDATED ZONE LOCATION ON CONTINUATION ARROWS TO LAW-M6-LVP-00005001 FROM H8 TO F8 AND LAW-M6-LVP-00001001 FROM C3 TO B3.
15. REVISION 4: INCORPORATED AND FURTHER REVISED 24590-LAW-M6N-LVP-00144, -00146, AND INFORMATION FROM 24590-LAW-EIE-NS-17-0001, REV 0. REVISED REFERENCE 1, CONTROL STRATEGY PER NEW PDSA, AND NOTE 14. MOVED TEST PORTS. ADDED LVP-ENCL-0021 AND LVP-ENCL-0022. ADDED CONNECTING LINE WITH FLOW DIRECTION ON BOTH SAMPLE BOOSTER PUMPS. ADDED YC-0560A AND YC-0560B LABEL TO OFF SHEET CONNECTOR AND QUALITY/SEISMIC BREAK. REMOVED L FROM TI-0554 AND TI-0552. UPDATED LOSS OF POWER OFF SHEET CONNECTOR WITH INSTRUMENT TAG NUMBERS. CORRECTED REVISION 3 NOTE. MISCELLANEOUS CHANGES PER EDR COMMENTS.
16. INSTRUMENT PROVIDED BY BECHTEL.
17. FOR SOME VENDOR SUPPLIED ITEMS, SEE ASSOCIATED VENDOR REFERENCES FOR DETAILS.
18. VALVE LOCKED OPEN DURING ANALYZER OPERATION. INADVERTANT CLOSURE MAY CAUSE EQUIPMENT DAMAGE.
19. REVSION 5: INCORPORATED 24590-LAW-M6N-LVP-00167, 24590-WTP-FC-IN-18-0042, 24590-WTP-SDDR-J-18-00014, AND CCN 308167.

HOLD OPEN ITEMS:

1. NONE

REFERENCES:

1. 24590-LAW-3ZD-LOP-00001, LAW PRIMARY OFFGAS PROCESS (LOP) AND LAW SECONDARY OFFGAS/VESSEL VENT PROCESS (LVP) SYSTEM DESIGN DESCRIPTION.
2. 24590-CD-POA-JA03-00007-07-00013 DRAWING - ANALYZER LVP-AT-0522 LVP-PNL-00028 / NH3 CALIBRATION GAS DISTRIBUTION MANIFOLD TUBING SCHEMATIC DIAGRAM.
3. 24590-CD-POA-JA03-00007-07-00008 DRAWING - ANALYZER LVP-AT-0523 LVP-PNL-00027 / SAMPLE SYSTEM TUBING SCHEMATIC DIAGRAM.

Originator By: J. ECKEL - ajeckel Org Name: BNI Placed: Jul 24, 2019
Checked By: Tyler Maki - tjmaki Org Name: Mechanical Systems Placed: Jul 24, 2019

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
5	REVISED PER NOTE 19			N/A	AMC CMN TRV	8/19/19
4	REVISED PER NOTE 15	TH	MO	NK	WJ/JS/JW	07/27/17
3	REVISED PER NOTE 14	LR	MRO	JS	DY/PR/JW	09/15/15
2	REVISED PER NOTE 13	DMH	MRO	BA/SS	JW/DC	08/22/14
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	MO	SJ	SS	TH/DM	11-22-11

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	O'NEILL, MICHAEL	11-18-11
CHECKER	JAIN, SATISH	11-18-11
APPROVER	HUGHES, T / MILDON, D.	11-22-11
REVIEWER	SCHMUDE, STEVEN	11-18-11

P&ID - LAW
LAW SECONDARY OFFGAS/VESSEL VENT PROCESS SYSTEM SCO/SCR SKID

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-023 REV: 5

SCALE: NONE
24590-LAW-M6-LVP-00005002
REV 5

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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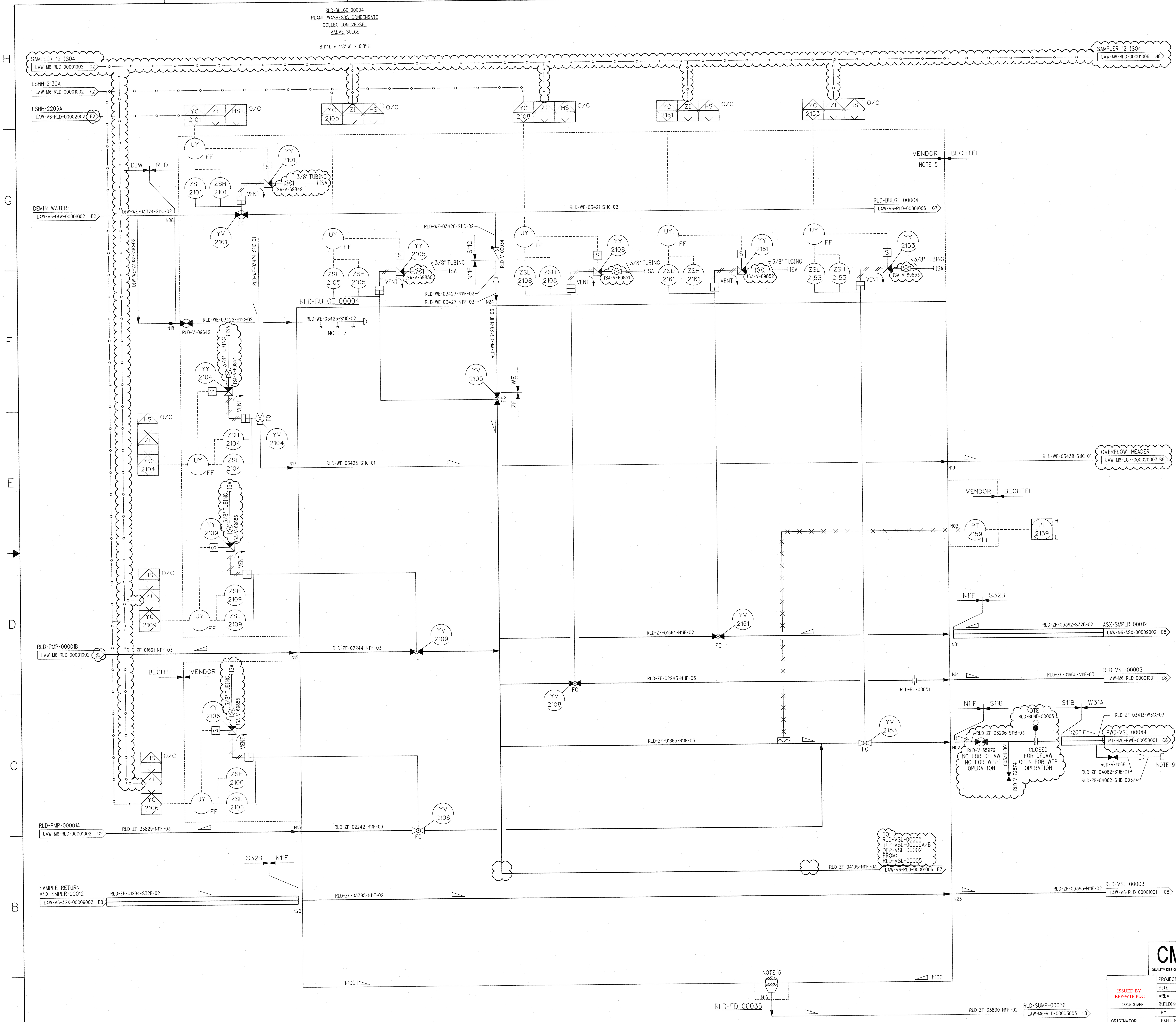
FORM IE_SDN.DGN 02/2009

24590-LAW-M6-RLD-00001005



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. VALVES, INSTRUMENTATION, AND PIPING INSIDE THE PHANTOM LINE ARE LOCATED OUTSIDE THE BULGE AND PROVIDED BY THE BULGE VENDOR.
6. STRAINER IS DESIGNED FOR MECHANICAL REMOVAL FROM THE BULGE EXTERIOR.
7. SPRAY NOZZLES PROVIDED BY BULGE VENDOR.
8. PLUG VALVES LOCATED INSIDE BULGES TO BE 316 SS, BUTT WELD ENDS, AND PROVIDED BY BULGE VENDOR.
9. LOCATE HOSE CONNECTION IN CORRIDOR AT ELEVATION 3'-0".
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-RLD-00001 REV 6. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-RLD-00043.
11. SPECTACLE BLIND IS PIPE CLASS S12C.
12. REVISION 1: INCORPORATED 24590-LAW-M6N-M80T-00016, -00085, 24590-LAW-M6N-RLD-00086, -00091, -00094, 24590-WTP-EIE-SYSE-15-0109, REV. 0, AND 24590-WTP-EIE-SYSE-16-0082, REV. 0. CHANGES ASSOCIATED WITH 24590-WTP-EIE-SYSE-15-0109 REV. 0 AND 24590-WTP-EIE-SYSE-16-0082, REV. 0 WERE INCORPORATED BY 24590-LAW-M6N-RLD-00086 AND 24590-LAW-M6N-RLD-00091. UPDATED OFF SHEET CONNECTORS AND REFERENCE 1.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-RLD-00001, LAW FACILITY RADIOACTIVE LIQUID WASTE DISPOSAL (RLD) SYSTEM DESIGN DESCRIPTION.
2. 24590-LAW-ADR-M-01-001 REV 3, ALARA DESIGN REVIEW OF LAW RLD SYSTEM.
3. 24590-WTP-ADR-M-16-0001 REV 4, ALARA DESIGN REVIEW OF BOF DEP SYSTEM.

PLEASE NOTE THAT SOURCE, SPECIAL NUCLEAR AND BYPRODUCT MATERIALS, AS DEFINED IN THE ATOMIC ENERGY ACT OF 1954 (AEA) ARE REGULATED AT THE U.S. DEPARTMENT OF ENERGY (DOE) FACILITIES EXCLUSIVELY BY DOE ACTING PURSUANT TO ITS AEA AUTHORITY. DOE ASSERTS, THAT PURSUANT TO THE AEA IT HAS SOLE AND EXCLUSIVE RESPONSIBILITY AND AUTHORITY TO REGULATE SOURCE, SPECIAL NUCLEAR AND BYPRODUCT MATERIALS AT DOE-OWNED NUCLEAR FACILITIES. INFORMATION CONTAINED HEREIN ON RADIONUCLIDES IS PROVIDED FOR PROCESS DESCRIPTION PURPOSES ONLY.

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 12	MRG	PW	[illegible]	RRB AMC	7/11/18
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	BF	ST	SK/SS	RS/JS	9/02/10

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590	
SITE	HANFORD	
AREA	200E	
BUILDING No.	20	
	BY	DATE
ORIGINATOR	FANT, BRIAN	8/31/10
CHECKER	THAKKAR, SURENDRA	9/1/10
APPROVER	STEVENS, ROBERT	9/2/10
REVIEWER	KRETZSCHMAR, STUART	9/1/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. SEE REFERENCES 2 AND 3 REV:

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW RADIOACTIVE LIQUID WASTE DISPOSAL SYSTEM PLANT WASH & SBS CONDENSATE COLLECTION RLD-BULGE-00004

SCALE: NONE
24590-LAW-M6-RLD-00001005
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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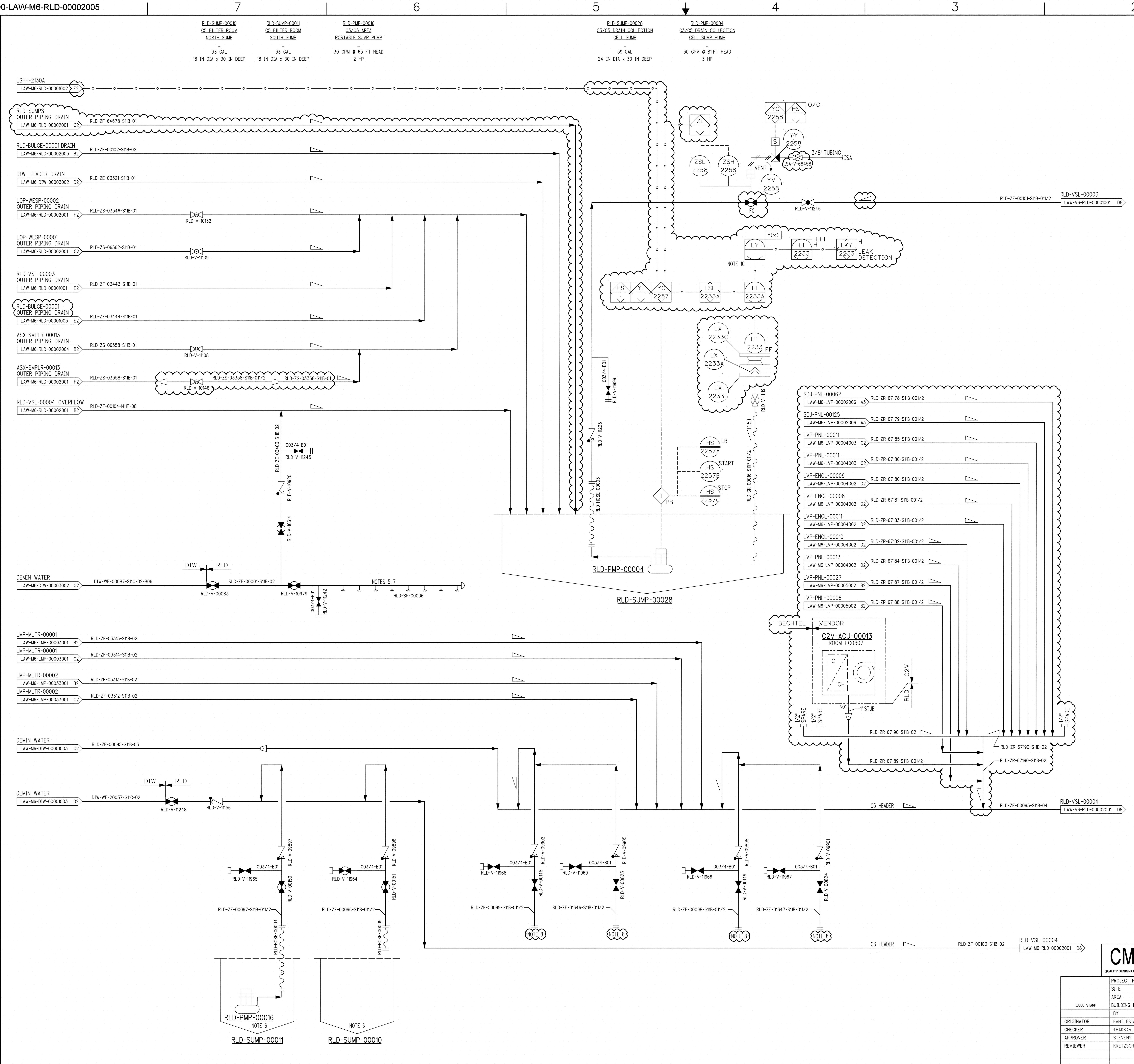
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. A SINGLE CELL WASH HEADER PROVIDES SPRAY FOR THE TOTAL PERIMETER FOR C3/C5 DRAIN TANK CELL ROOM L-B001B.
6. ONE PORTABLE WAREHOUSE PUMP RLD-PMP-00016 WILL BE PROVIDED FOR C3 AND C5 AREAS.
7. 16 SPRAY NOZZLES SPACED ON 5'-0" CENTERS.
8. PUMP DISCHARGE FLANGED CONNECTIONS LOCATED AT END OF MELTER POUR CAVES ONE AND TWO.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-RLD-00002 REV 6. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-20-00001, 24590-LAW-M6N-RLD-00044, AND 24590-LAW-M6PN-RLD-00003.
10. FUNCTION CONVERTS SUMP LEVEL IN INCHES TO GALLONS.
11. REVISION 1: INCORPORATED 24590-LAW-M6N-RLD-00053, -00064, -00080, -00087, -00090, -00091, 24590-LAW-M6N-M80T-00016, -00043, 24590-WTP-FC-P-12-0217, 24590-WTP-M6N-50-00073, 24590-WTP-EIE-J-16-0001 (REV 0), AND 24590-LAW-M6N-20-00019. REVISED REMOTE RADAR LEVEL INSTRUMENT AND PIPE SLOPE. ADDED PIPELINE NUMBER.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-RLD-00001, REV 1, LAW FACILITY RADIOACTIVE LIQUID WASTE DISPOSAL (RLD) SYSTEM DESIGN DESCRIPTION
2. 24590-LAW-ADR-M-01-001, REV. 3, DESIGN REVIEW OF P&IDS INCLUDING ALARA CONSIDERATIONS FOR RLD SYSTEM.
3. 24590-WTP-ADR-J-06-0001, REV. 2, RADAR LEVEL INSTRUMENTATION.
4. 24590-WTP-ADR-J-14-0001, REV. 0, THERMAL CONNECTIVITY LEVEL INSTRUMENTATION.

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 11	DF	WJD	CER	DAH	2/12/18
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	BF	ST	SK/SS	RS/JJ	09/02/10

REVISION HISTORY

ISSUE STAMP		
PROJECT No.	24590	
SITE	HANFORD	
AREA	200E	
BUILDING No.	20	
	BY	DATE
ORIGINATOR	FANT, BRIAN	8/31/10
CHECKER	THAKKAR, SURENDRA	9/1/10
APPROVER	STEVENS, ROBERT	9/2/10
REVIEWER	KRETZSCHMAR, STUART	9/1/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. SEE REFERENCES 2,3,4 REV: N/A

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW RADIOACTIVE LIQUID WASTE DISPOSAL SYSTEM C3/C5 SUMPS RLD-SUMP-00010/-00011/-00028

SCALE: NONE
24590-LAW-M6-RLD-00002005
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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FORM E_SDN.DGN 02/2009

Quarter Ending: June 30, 2020

24590-LAW-PCN-ENV-19-010

RCRA Operating record number: R605

Hanford Facility RCRA Permit Modification Notification Form
Part III, Operating Unit 10
Waste Treatment and Immobilization Plant

Index

Submitted by Co-Operator:

Robert Haggard

Robert D. Haggard

05/08/2020

Date

Reviewed by ORP Program Office:

Digitally signed by Thomas W. Fletcher
Date: 2020.06.02 11:19:51 -07'00'

Thomas W. Fletcher

06/02/2020

Date

Document for Signature

Document Number: 24590-LAW-PCN-ENV-19-010 **Rev:** 0

Participants	Signature	Completed	Status	Result	Comments
Signers **5/8/2020 9:48 AM**					
Haggard, Robert		5/8/2020 10:34 AM	Completed	Approve	
Final Approver **5/8/2020 10:34 AM**					
Casey, Dianne		5/8/2020 11:06 AM	Completed	Approve	

Quarter Ending: June 30, 2020 24590-LAW-PCN-ENV-19-010

RCRA Operating record number: R605

Hanford Facility RCRA Permit Modification Notification Form	
Unit: **Waste Treatment and Immobilization Plant**	Permit Part: **Part III, Operating Unit 10**

Description of Modification:

The purpose of this Class 1 prime modification is to replace the following Piping and Instrument Diagram in Appendix 9.2 of the DWP:

Appendix 9.2			
Replace:	24590-LAW-M6-LMP-00007001, Rev 0	With:	24590-LAW-M6-LMP-00007001, Rev 1
Replace:	24590-LAW-M6-LMP-00007002, Rev 0	With:	24590-LAW-M6-LMP-00007002, Rev 2
Replace:	24590-LAW-M6-LMP-00008001, Rev 0	With:	24590-LAW-M6-LMP-00008001, Rev 2
Replace:	24590-LAW-M6-LMP-00010001, Rev 0	With:	24590-LAW-M6-LMP-00010001, Rev 2
Replace:	24590-LAW-M6-LMP-00012001, Rev 0	With:	24590-LAW-M6-LMP-00012001, Rev 1
Replace:	24590-LAW-M6-LMP-00013002, Rev 0	With:	24590-LAW-M6-LMP-00013002, Rev 2
Replace:	24590-LAW-M6-LMP-00033001, Rev 0	With:	24590-LAW-M6-LMP-00033001, Rev 1
Replace:	24590-LAW-M6-LMP-00037001, Rev 0	With:	24590-LAW-M6-LMP-00037001, Rev 1
Replace:	24590-LAW-M6-LMP-00037002, Rev 0	With:	24590-LAW-M6-LMP-00037002, Rev 1
Replace:	24590-LAW-M6-LMP-00038001, Rev 0	With:	24590-LAW-M6-LMP-00038001, Rev 2
Replace:	24590-LAW-M6-LMP-00040001, Rev 0	With:	24590-LAW-M6-LMP-00040001, Rev 2
Replace:	24590-LAW-M6-LMP-00042001, Rev 0	With:	24590-LAW-M6-LMP-00042001, Rev 1
Replace:	24590-LAW-M6-LMP-00043002, Rev 0	With:	24590-LAW-M6-LMP-00043002, Rev 2
Replace:	24590-LAW-M6-LMP-00003001, Rev 0	With:	24590-LAW-M6-LMP-00003001, Rev 1

This modification requests Ecology approval and incorporation into the permit the specific changes to the Piping and Instrument Diagram (P&ID).

(24590-LAW-M6-LMP-00007001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Glass Pouring and Monitoring Instrumentation, are summarized below:

- Note 7: updated the high high level from the thermal imaging system automatically shuts down the melter discharge.
- Note 9: deleted
- Note 11: deleted
- New Note 12: Discrete output to the LMP-LT-1511 indicating container present (LPH-WE-4005A/B) and in pour position (LPH-ZS-4001). Reference 24590-LAW-M7-LPH-00001009.
- New Note 13: Discrete output to LMP-LT-1511 indicating glass is pouring when LMP-YV-1047 valve is commanded open.
- New Note 14: PCV has integral indicator
- New Note 15: Revision 1 has incorporated 24590-LAW-M6N-LMP-M80T-00016, 24590-LAW-M6N-LMP-00090, -00094, and -00105. Deleted PSUP and note 11 in response to 24590-WTP-FC-E-18-0536. Updated reference 1 and ADR revision.
- Hold/open items have been deleted
- Reference has been updated as described above in Note 15

(24590-LAW-M6-LMP-00007002, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Glass Pouring and Monitoring Instrumentation, are summarized below:

- Note 7: Revision 1 updated the high high level from the thermal image system automatically shuts down the melter discharge.
- Note 9: deleted with revision 1
- Note 11: deleted

- New Note 12: Discrete output to LMP-LT-1466 indicating container present (LPH-WE-3505A/B) and in pour position (LPH-ZS-3501). Reference 24590-LAW-M7-LPH-00001007.
- New Note 13: Discrete output to LMP-LT-1466 indicating glass is pouring when LMP-YV-1125 valve is commanded open.
- New Note 14: PCV has integral indicator
- New Note 15: Revision 1 incorporated 24590-WTP-FC-P-17-0209, 25490-LAW-M6N-M80T-00016, 24590-LAW-M6N-LMP-00090, -00094, and -00105. Deleted PSUP and note 11 in response to 24590-WTP-FC-E-18-0536. Updated reference 1 and ADR revision
- Hold/open items have been deleted
- Reference has been updated

(24590-LAW-M6-LMP-00008001, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Discharge Heaters, Power Controls (1-4) and Air Lift – Eastside, are summarized below:

- Note 11: Revision 1 updated the high high container weight (LPH-WE-4005A/b) closes valve LMP-YV-1047 to stop pour and prevent container overfill. Container weight (LPH-WE-4005A/B) and position (LPH-ZS-4001) prevents glass pouring when a container is not in pouring position. Reference drawing 24560-LAW-M7-LPH-00001009.
- Note 18: added with revision 1 to incorporate 24590-LAW-M6N-LMP-00089, -00104, and -00105. Updated reference 1 and ADR revision.
- New note 19: Revision 2 added ball valves to align with vendor drawings.
- Reference 1: changed to 24590-LAW-3ZD-LMP-00001, system description for the low-activity waste melter process system design description.

(24590-LAW-M6-LMP-00010001, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Discharge Heaters, Power Controls (1-4) and Air Lift – Westside, are summarized below:

- Note 11: Revision 1 updated the high high container weight (LPH-WE-3505A/B) closes valve LMP-YV-1125 to stop pour and prevent container overfill. Container weight (LPH-WE-3505A/B) and position (LPH-ZS-3501) prevents glass pouring when a container is not in pouring position. Reference drawing 24590-LAW-M7-LPH-00001007.
- Note 17: added with revision 1 to incorporate 24590-LAW-M6N-LMP-00089, -00104, and -00105. Updated reference 1 and ADR revision.
- New Note 18: revision 2 added ball valves to align with vendor drawings.
- Reference 1: 24590-LAW-3ZD-LMP-00001, low-activity waste melter process (LMP) system design description.
- Drawing index was updated to 24590-LAW-M6-LMP-00010001 LAW melter process system melter 1 discharge heaters, power controls (1-4) and air lift-westside.

(24590-LAW-M6-LMP-00012001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Feed Nozzles Cooling System and Feed Nozzles, are summarized below:

- Note 5: updated valve setting shall limit flow to melt pool in the event of a breach in the cooling jacket of the feed nozzle. Valves shall be set for prescribed flow rate then administratively controlled in this position. Valve is purchased by mechanical systems per 24590-CM-MRA-PV21-00004.
- Note 10: revision 1 incorporated 24590-LAW-M6N-LMP-00109 and added Bechtel/Vendor boundary. Updated off sheet connectors, ADR revision, drawing index, Reference 1, and note 5.
- Reference 1: updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process (LMP) system design description
- Drawing index was updated to 24590-LAW-M6-LMP-00012001 LAW melter process system melter 1 feed nozzles cooling system and feed nozzles.

(24590-LAW-M6-LMP-00013002, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 1 Lid Cooling Loop, are summarized below:

- Note 5: deleted

Quarter Ending: June 30, 2020 24590-LAW-PCN-ENV-19-010

RCRA Operating record number: R605

- Note 6: revision 1 added, setpoint and physical location of PSV prevents overpressure in gas barrier lid cooling department
- Note 7: deleted in revision 1
- Note 10: revision 1 added, construction shall field route tubing from indicated location on pipe to flush port on vendor supplied pump shaft seal. Refer to mechanical systems tubing detail 24590-WTP-M0-50-00083
- Note 11: revision 1 added, distance from heat exchanger nozzle to branch for PSV not to exceed 3 feet
- Note 12: revision 1 incorporated 24590-LAW-M6N-LMP-00081, -00091, -00103, 24590-WTP-FC-M-14-0036, 24590-WTP-FC-P-15-0062, and 24590-LAW-EIE-NS-17-0001 Rev 0. Changes associated with 24590-LAW-EIE-NS-17-0001 Rev 0 were overcome by DSA driven changes contained in 24590-LAW-M6N-LMP-00103. Revised references and ADR revision number.
- Note 13: revision 2 deleted note 5 in response to 24590-WTP-FC-P-18-0173. Deleted PP from LMP-PMP-00001 and LMP-PMP-00002, which corrected omission from 24590-WTP-FC-P-15-0062 in previous revision.
- Reference 1: updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process system design description.

(24590-LAW-M6-LMP-00033001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Walls and Floor Panels Cooling System, are summarized below:

- Note 4: updated to remove spring from piston check valve and install in horizontal piping
- Note 9: updated note with new documentation that the following 24590-WTP-M0-50-00074 drawing will define routing
- Note 11: revision 1 incorporated 24590-LAW-M6N-LMP-00055 and -00102. Updated reference, ADR revision and off sheet connectors
- Reference 1: updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process system design description

(24590-LAW-M6-LMP-00037001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Glass Pouring and Monitoring Instrumentation, are summarized below:

- Note 7: updated the high high level from the thermal image system automatically shuts down the melter discharge
- Note 9: deleted
- Note 11: deleted
- Note 12: added discrete output to LMP-LT-2511 indicating container present (LPH-WE-5205A/B) and in pour position (LPH-ZS-5201). Reference 24590-LAW-M7-LPH-00001013.
- Note 13: added discrete output to LMP-LT-2511 indicating glass is pouring when LMP-YV-2047 valve is commanded open
- Note 14: added PCV had integral indicator
- Note15: revision 1 incorporated 24590-LAW-M6N-LMP-M80T-00016, 24590-LAW-M6N-LMP-M80T-00083, -00090, -00094 and -000105. Deleted PSUP and note 11 in response to 24590-WTP-FC-E-18-0536. Updated reference 1 and ADR revision
- Hold/Open items: deleted
- Reference 1: updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process (LMP) system design description.

(24590-LAW-M6-LMP-00037002, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Glass Pouring and Monitoring Instrumentation, are summarized below:

- Note 7: updated the high high level from the thermal image system automatically shuts down the melter discharge
- Note 9: deleted
- Note 11: deleted
- Note 12: added the discrete output to LMP-LT-2466 indicating container present (LPH-WE-4605A/B) and in pour position (LPH-ZS-4601). Reference 24590-LAW-M7-LPH-00001011

Quarter Ending: June 30, 2020 24590-LAW-PCN-ENV-19-010

RCRA Operating record number: R605

- Note 13: added the discrete output to LMP-LT-2466 indicating glass is pouring when LMP-YV-2125 valve is commanded open
- Note 14: PCV has integral indicator
- Note 15: revision 1 incorporated 24590-LAW-M6N-LMP-M80T-00016, 24590-WTP-FC-SU-18-0115, 24590-LAW-M6N-LMP-00090, -00094, and -00105. Deleted PSUP and note 11 in response to 24590-WTP-FC-E-18-0536. Updated reference 1 and ADR revision
- Hold/Open items: deleted
- Reference 1: updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process (LMP) system design description
- Reference 2: updated to 24590-LAW-M7-LPH-00001011, LAW vitrification system LPH mechanical handling diagram container pour handling system.

(24590-LAW-M6-LMP-00038001, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Discharge Heaters, Power Controls (1-4) and Air Lift – Eastside, are summarized below:

- Note 11: revision 1 updated to high high container weight (LPH-WE-5205A/B) closes valve LMP-YV-2047 to stop pour and prevent container overfill. Container weight (LPH-WE-5205A/B) and position (LPH-ZS-5201) prevent glass pouring when a container is not in pouring position. Reference drawing 24590-LAW-M7-LPH-00001013
- Note 18: revision 1 incorporated 24590-LAW-M6N-LMP-00089, -00104, and -00105 updated reference 1, ADR revision, and equipment tag number
- Reference 1: revision 1 updated to 24590-LAW-3ZD-LMP-00001, low-activity waste melter process (LMP) system design description.
- Note 19: revision 2 added ball valves to align with vendor drawings

(24590-LAW-M6-LMP-00040001, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Discharge Heaters, Power Controls (1-4) and Air Lift – Westside, are summarized below:

- Note 11: revision 1 updated to high high container weight (LPH-WE-4605A/B) closes valve LMP-YV-2125 to stop pour and prevent container overfill. Container weight (LPH-WE-4605A/B) and position (LPH-ZS-4601) prevents glass pouring when a container is not in pouring position. Reference drawing 24590-LAW-M7-LPH-00001011.
- Note 17: revision 1 incorporated 24590-LAW-M6N-LMP-00089, -00104, and -00105. Updated reference 1, drawing index, and ADR revision
- Reference 1: revision 1 updated to 24590-LAW-3ZD-LMP-00001, low-activity waste melter process (LMP) system design description
- Note 18: revision 2 added ball valves to align with the vendor drawings
- Drawing index was updated to 24590-LAW-M6-LMP-00040001, LAW melter process system melter 2 discharge heaters, power controls (1-4) and air-lift – westside
- The draw number shows **2**24590 on the document. This typo will be notified to Engineering to correct in the next revision.

(24590-LAW-M6-LMP-00042001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Feed Nozzles Cooling System and Feed Nozzles, are summarized below:

- Note 5: revision 1 updated, valve setting shall limit flow to melt pool in the event of a breach in the cooling jacket of the feed nozzle. Valves shall be set for prescribed flow rate then administratively controlled in this position. Valve is purchased by mechanical systems per 24590-CM-MRA-PV21-00004.
- Note 10: revision 1 incorporated 24590-LAW-M6N-LMP-00109 and added Bechtel/vendor boundary. Updated off sheet connectors, ADR revision, drawing index, reference 1, and note 5.
- Reference 1 updated to 24590-LAW-3ZD-LMP-00001, low-activity waste melter process (LMP) system design description
- Drawing index updated to 24590-LAW-M6-LMP-00042001, LAW melter process system melter 2 feed nozzles cooling system and feed nozzles

Quarter Ending: June 30, 2020 24590-LAW-PCN-ENV-19-010

RCRA Operating record number: R605

(24590-LAW-M6-LMP-00043002, Rev 2) Changes to the Piping and Instrument Diagram for the LAW Melter Process System, Melter 2 Melter Lid Cooling Loop, are summarized below:

- Note 5: deleted in revision 2
- Note 6: revision 1 updated setpoint and physical location of PSV prevents overpressure in gas barrier lid cooling compartment
- Note 7: revision 1 deleted
- New Note 10: revision 1 added construction shall field route tubing from indicated location on pipe to flush port on vendor supplied pump shaft seal. Refer to mechanical systems tubing detail 24590-WTP-M0-50-00083
- New Note 11: revision 1 added distance from heat exchanger nozzle to branch for PSV not to exceed 3 feet
- New Note 12: revision 1 incorporated 24590-LAW-M6N-LMP-00081, -00091, -00097, -00103, 24590-WTP-FC-P-15-0062, and 24590-LAW-EIE-NS-17-0001 Rev 0. Changes associated with 24590-LAW-EIE-NS-17-0001 Rev 0 were overcome by DSA driven changes contained in 24590-LAW-M6N-LMP-00103. Revised reference and ADR revision number.
- Reference 1: revision 1 updated 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process system design description
- New Note 13: revision 2 deleted note 5 in response to 24590-WTP-FC-P-18-0173. Deleted PP from LMP-PMP-00003 and LMP-PMP-00004, which corrected omission from 24590-WTP-FC-P-15-0062 in previous revision

(24590-LAW-M6-LMP-00003001, Rev 1) Changes to the Piping and Instrument Diagram for the LAW Melter Process System Melter 1 Walls and Floor Panels Cooling System, are summarized below:

- Note 4: updated to remove spring from piston check valve and install in horizontal piping
- Note 9: revision 1 updated construction shall field route tubing from PSV sensing line port to cooling water supply piping near connection CLG08. Mechanical systems connection detail series 24590-WTP-M0-50-00074 drawing will define routing
- Note 11: revision 1 incorporated 24590-LAW-M6N-LMP-00055 and -00102. Updated reference 1 and off sheet connectors
- Reference 1 updated to 24590-LAW-3ZD-LMP-00001, Low-activity waste melter process system design description

WAC 173-303-830 Modification Class:	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number: A.3

Enter wording of WAC 173-303-830, Appendix I Modification citation: Equipment replacement or upgrading with functionality equivalent components (e.g., pipes, valves, pumps, conveyors, controls).

Modification Approved/Concur: [X] Yes [ ] Denied *(state reason below)*

Reason for denial:

Reviewed by Ecology:

Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.07.09 14:54:31 -07'00'

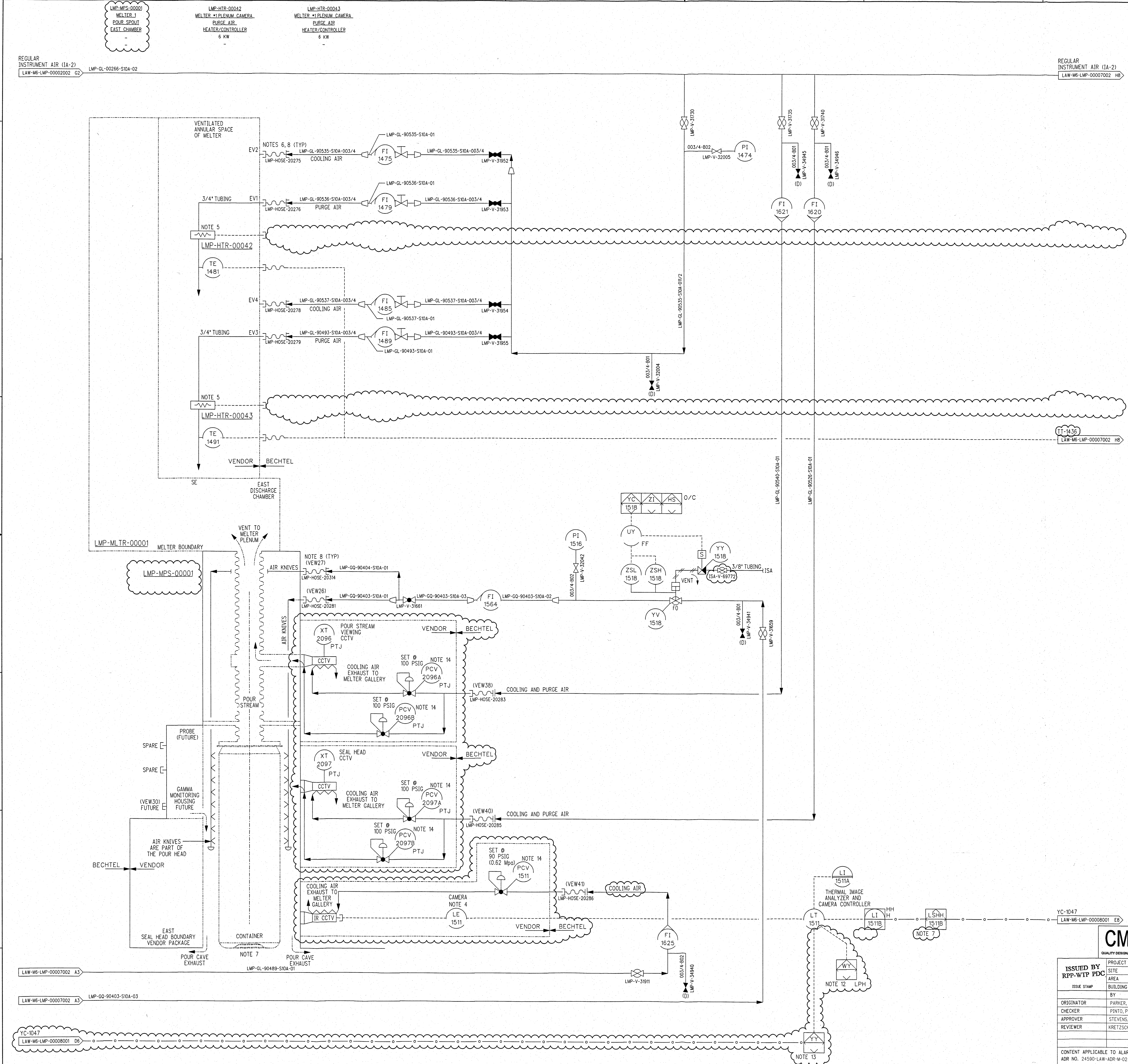
S. Schleif Date

Attachment 2
20-ECD-0030

Piping and Instrumentation Diagrams

24590-LAW-M6-LMP-00007001 Rev 1
24590-LAW-M6-LMP-00007002 Rev 2
24590-LAW-M6-LMP-00008001 Rev 2
24590-LAW-M6-LMP-00010001 Rev 2
24590-LAW-M6-LMP-00012001 Rev 1
24590-LAW-M6-LMP-00013002 Rev 2
24590-LAW-M6-LMP-00033001 Rev 1
24590-LAW-M6-LMP-00037001 Rev 1
24590-LAW-M6-LMP-00037002 Rev 1
24590-LAW-M6-LMP-00038001 Rev 2
24590-LAW-M6-LMP-00040001 Rev 2
24590-LAW-M6-LMP-00042001 Rev 1
24590-LAW-M6-LMP-00043002 Rev 2
24590-LAW-M6-LMP-00003001 Rev 1

(15 Pages Including Cover Sheet)



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. THE IR CAMERA DETECTS GLASS LEVEL (THERMAL TRANSITION REGION) ON CONTAINER.
5. AIR PRE-HEATER FOR FUTURE CCTV VIEWPORT.
6. AIR FOR FUTURE PLENUM CCTV.
7. HIGH HIGH LEVEL FROM THE THERMAL IMAGE SYSTEM AUTOMATICALLY SHUTS DOWN THE MELTER DISCHARGE.
8. SERVICE SIDE OF FLEX CONNECTION IS FEMALE CAMLOCK BY PLANT EQUIPMENT GROUP.
9. DELETED
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00007 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00035, AND -00057.
11. DELETED
12. DISCRETE OUTPUT TO LMP-LT-1511 INDICATING CONTAINER PRESENT (LPH-WE-4005A/B) AND IN POUR POSITION (LPH-ZS-4001). REFERENCE 24590-LAW-M7-LPH-00001009.
13. DISCRETE OUTPUT TO LMP-LT-1511 INDICATING GLASS IS POURING WHEN LMP-YV-1047 VALVE IS COMMANDED OPEN.
14. PCV HAS INTEGRAL INDICATOR.
15. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-M80T-00016, 24590-LAW-M6N-LMP-00090, -00094, AND -00105. DELETED PSUP AND NOTE 11 IN RESPONSE TO 24590-WTP-FC-E-18-0536. UPDATED REFERENCE 1 AND ADR REVISION.

HOLD/OPEN ITEMS:

1. DELETED

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00007001	MELTER PROCESS SYS MONITORING INSTRUMENTATION
24590-LAW-M6-LMP-00007002	MELTER PROCESS SYS MONITORING INSTRUMENTATION

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 15	DJA	BWJ	KES	RRB AC TRV	4/17/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	08/30/10

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/17/10
CHECKER	PINTO, PAT	08/17/10
APPROVER	STEVENS,R/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	08/25/10

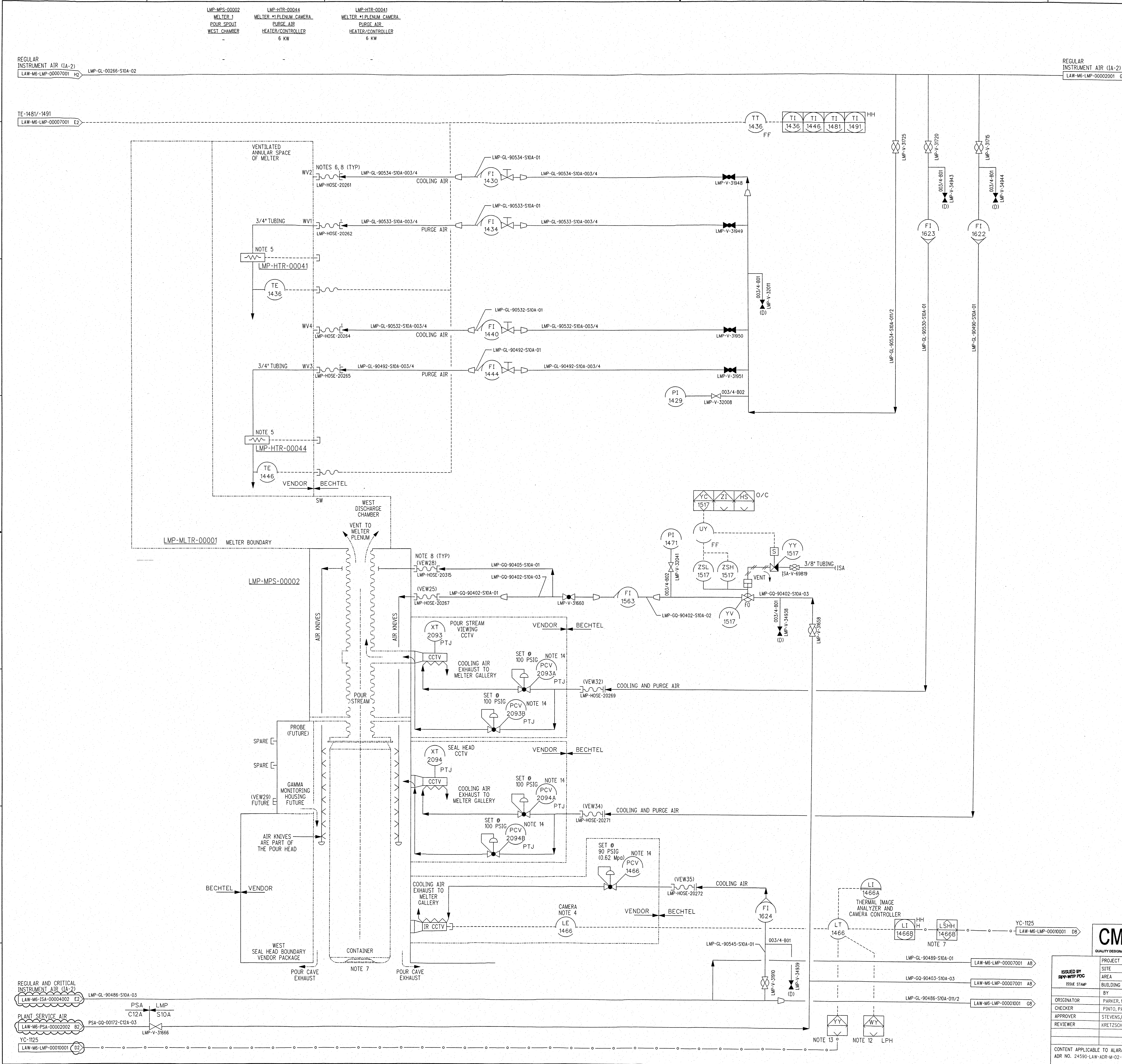
CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

P&ID - LAW
LAW MELTER PROCESS SYSTEM
MELTER 1
GLASS POURING AND MONITORING INSTRUMENTATION

SCALE: NONE
24590-LAW-M6-LMP-00007001
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11924948



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. THE IR CAMERA DETECTS GLASS LEVEL (THERMAL TRANSITION REGION) ON CONTAINER.
5. AIR PRE-HEATER FOR FUTURE CCTV VIEW PORT.
6. AIR FOR FUTURE PLENUM CCTV.
7. HIGH HIGH LEVEL FROM THE THERMAL IMAGE SYSTEM AUTOMATICALLY SHUTS DOWN THE MELTER DISCHARGE.
8. SERVICE SIDE OF FLEX CONNECTION IS FEMALE CAMLOCK BY PLANT EQUIPMENT GROUP.
9. DELETED
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00007 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00035, AND -00057.
11. DELETED
12. DISCRETE OUTPUT TO LMP-LT-1466 INDICATING CONTAINER PRESENT (LPH-WE-3505A/B) AND IN POUR POSITION (LPH-ZS-3501). REFERENCE 24590-LAW-M7-LPH-00001007.
13. DISCRETE OUTPUT TO LMP-LT-1466 INDICATING GLASS IS POURING WHEN LMP-YV-1125 VALVE IS COMMANDED OPEN.
14. PCV HAS INTEGRAL INDICATOR.
15. REVISION 1: INCORPORATED 24590-WTP-FC-P-17-0209, 24590-LAW-M6N-LMP-MB0T-00016, 24590-LAW-M6N-LMP-00090, -00094, AND -00105. DELETED PSUP AND NOTE 11 IN RESPONSE TO 24590-WTP-FC-E-18-0536. UPDATED REFERENCE 1 AND ADR REVISION.

HOLD/OPEN ITEMS:

1. DELETED

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED OFF SHEET CONNECTORS (MINOR CHANGE)	TJ	N/A	KRL	CMW AC TRV	8/1/19
1	REVISED PER NOTE 15	DJA	BWJ	KRS	AC/RB/TV	04/12/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	08/30/10

REVISION HISTORY

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/17/10
CHECKER	PINTO, PAT	08/18/10
APPROVER	STEVENS,R/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	08/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

BECHTEL
RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 1 GLASS POURING AND MONITORING INSTRUMENTATION

SCALE: NONE
24590-LAW-M6-LMP-00007002
REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11958352

7/23/2019 10:00:42 AM

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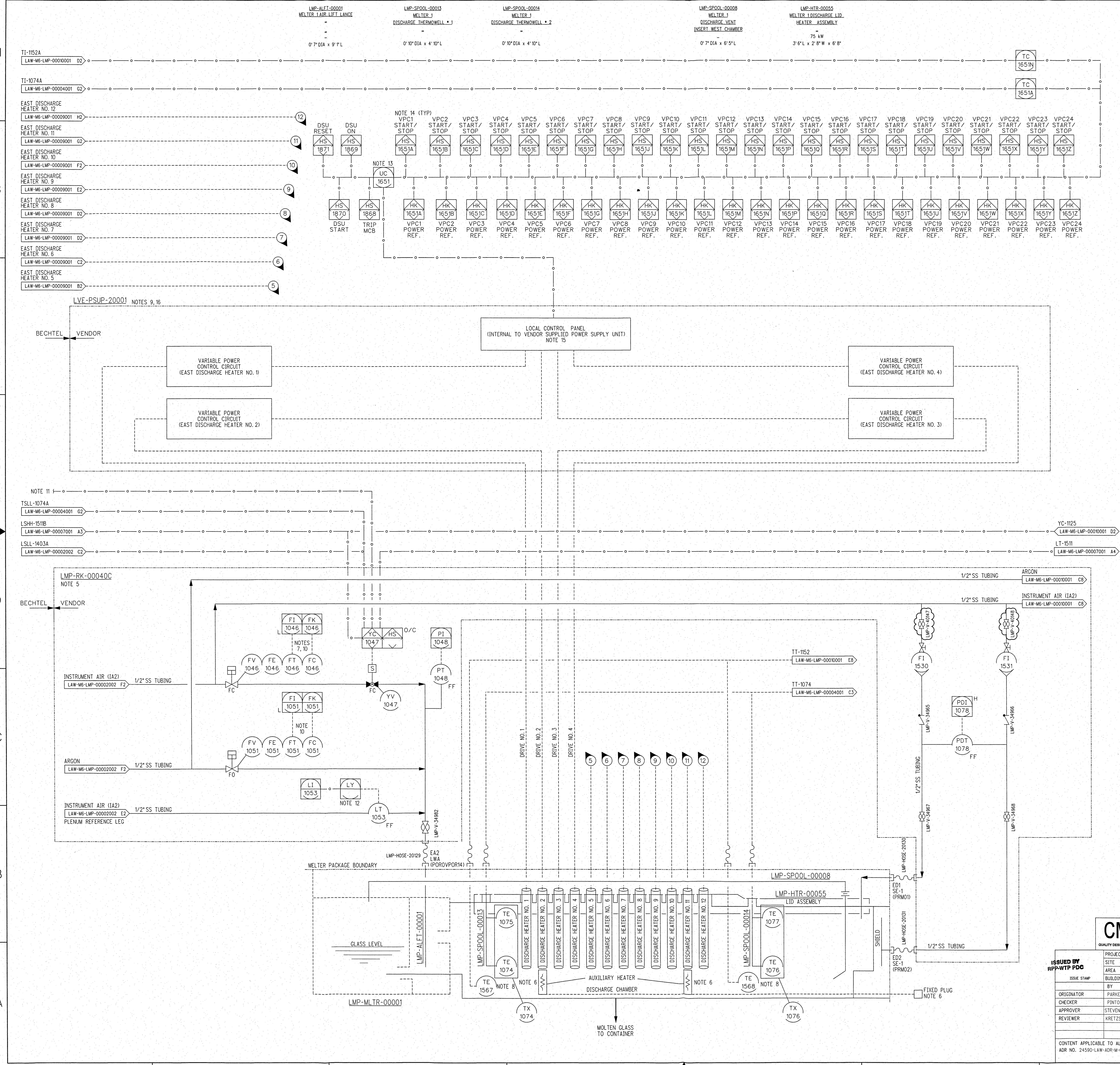
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWWISE NOTED.
5. ALL INSTRUMENTS AND VALVING FOR AIR LIFT SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE SHIELD WALL TO REDUCE LINE CAPACITANCE AND AIR LIFT SURGING.
6. DISCHARGE AUXILIARY HEATERS PREWIRED TO PLUG FOR USE, AS REQUIRED BY OPERATIONS.
7. WHEN VALVE LMP-YV-1047 IS NOT OPEN, SETPOINT TO LMP-FC-1046 IS FORCED TO ZERO PERCENT.
8. TE-1567 AND TE-1568 ARE INTEGRAL WITH AUXILIARY HEATER AND ARE NOT REPLACEABLE.
9. FOR ELECTRICAL SUPPLY DESIGN SEE DRAWING 24590-LAW-E1-LVE-00031.
10. FLOW CONTROL (FC) IS INTEGRAL TO THE VALVE. ACTUAL SETPOINT PROVIDED FROM ICN.
11. HIGH HIGH CONTAINER WEIGHT (LPH-WE-4005A/B) CLOSES VALVE LMP-YV-1047 TO STOP POUR AND PREVENT CONTAINER OVERFILL. CONTAINER WEIGHT (LPH-WE-4005A/B) AND POSITION (LPH-ZS-4001) PREVENTS GLASS POURING WHEN A CONTAINER IS NOT IN POURING POSITION. REFEENCE DRAWING 24590-LAW-M7-LPH-00001009.
12. LMP-DI-1404 ON DRAWING 24590-LAW-M6-LMP-00002002 IS BACK UP TO CALCULATING ALTERNATE LEVEL IN LMP-LI-1053.
13. DISCHARGE HEATER POWER SUPPLY OPERATION IS INITIATED AND OPERATIONAL STATUS IS MONITORED FROM THE FACILITY CONTROL SYSTEM. TAG REPRESENTS MULTIPLE CONTROL AND INDICATING PARAMETERS FOR ALL EAST AND WEST DISCHARGE CHAMBER HEATERS AVAILABLE TO FACILITY OPERATOR. CONTROL SIGNAL ORIGINATES FROM AVERAGE DISCHARGE CHAMBER TEMPERATURES.
14. EACH HEATER VPC HAS A START/STOP HAND SWITCH AND A REFERENCE AUTO/MANUAL STATION. EAST CHAMBER HEATERS ARE VPC1 THROUGH VPC12. WEST CHAMBER HEATERS ARE VPC13 THROUGH VPC24.
15. POWER SUPPLY SEPARATELY CONTROLS BOTH THE EAST AND WEST DISCHARGE CHAMBERS.
16. FOR PACKAGE DETAILS, SEE DRAWING 24590-CM-POA-EY00-00002-03-00005.
17. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00008 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00022, AND -00058.
18. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00089, -00104, AND -00105. UPDATED REFERENCE 1 AND ADR REVISION.
19. REVISION 2: ADDED BALL VALVES TO ALIGN WITH VENDOR DRAWINGS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, SYSTEM DESCRIPTION FOR THE LOW -ACTIVITY WASTE MELTER PROCESS SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00008001	LAW MELTER PROCESS SYSTEM

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 19	VC	MHS	KES	CMN AC TRV	9/11/19
1	REVISED PER NOTE 18	BLR	TM	N/A	AL/CN/TV	6/04/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 17	MP	APP	SK/SS	RS/JS	8/30/10

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590	
SITE	HANFORD	
AREA	200E	
BUILDING No.	20	
	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/23/10
CHECKER	PINTO, PAT	8/23/10
APPROVER	STEVENS, R/SCHNEIDER, J	8/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 1 DISCHARGE HEATERS, POWER CONTROLS (1 - 4) AND AIR LIFT - EASTSIDE

SCALE: NONE
24590-LAW-M6-LMP-00008001
REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11959645

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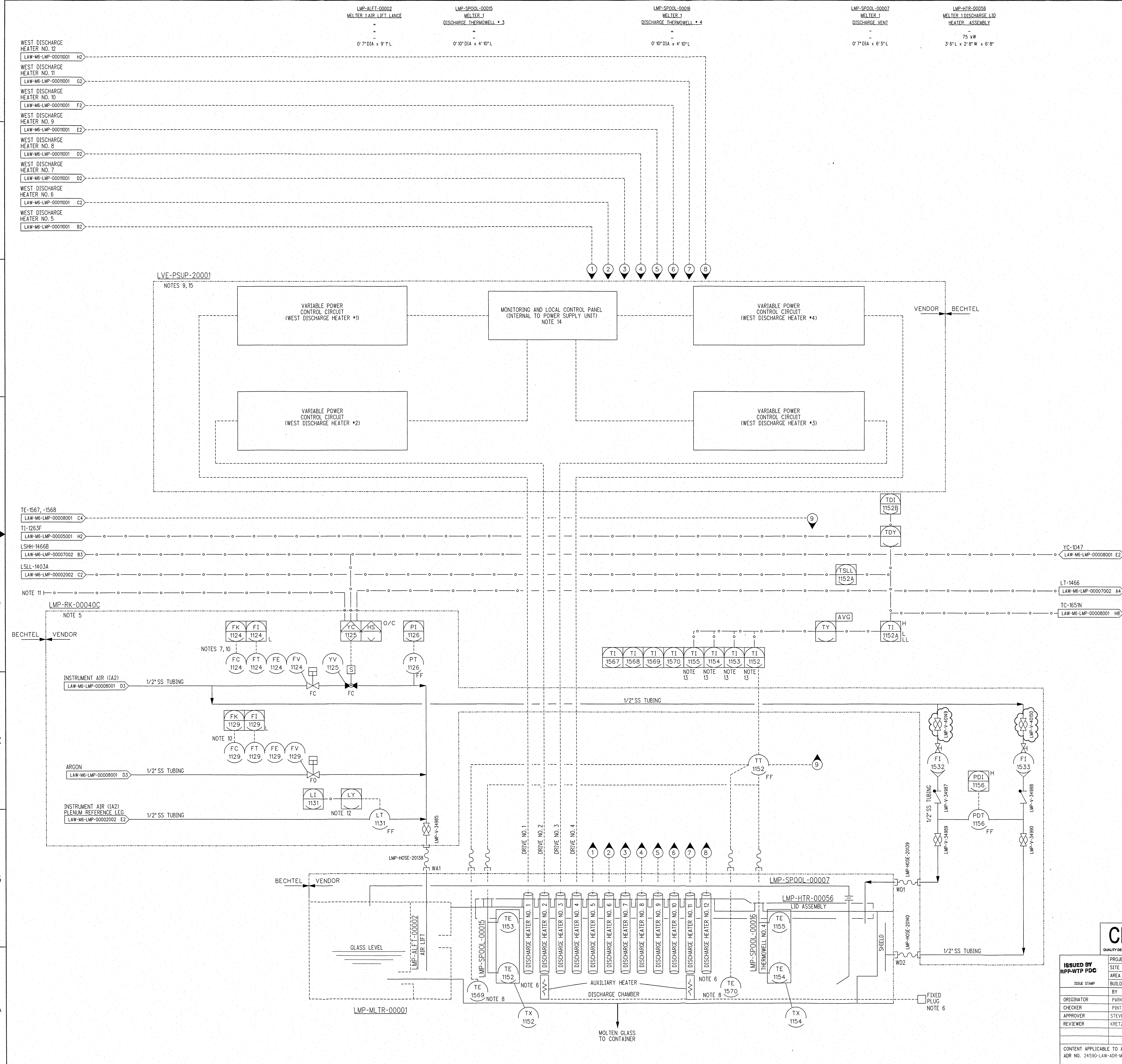

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS ON THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. ALL INSTRUMENTS AND VALVING FOR AIR LIFT SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE SHIELD WALL TO REDUCE LINE CAPACITANCE AND AIR LIFT SURGING.
6. DISCHARGE AUXILIARY HEATERS PREWIRED TO PLUG FOR USE, AS REQUIRED BY OPERATIONS.
7. WHEN VALVE LMP-YV-1125 IS NOT OPEN, SETPOINT TO LMP-FC-1124 IS FORCED TO ZERO PERCENT.
8. TE-1569 AND TE-1570 ARE INTEGRAL WITH AUXILIARY HEATER AND ARE NOT REPLACEABLE.
9. FOR ELECTRICAL SUPPLY DESIGN SEE DRAWING 24590-LAW-E1-LVE-00031.
10. FLOW CONTROL (FC) IS INTEGRAL TO THE VALVE. ACTUAL SETPOINT PROVIDED FROM ICN.
11. HIGH HIGH CONTAINER WEIGHT (LPH-WE-3505A/B) CLOSES VALVE LMP-YV-1125 TO STOP POUR AND PREVENT CONTAINER OVERFILL. CONTAINER WEIGHT (LPH-WE-3505A/B) AND POSITION (LPH-ZS-3501) PREVENTS GLASS POURING WHEN A CONTAINER IS NOT IN POURING POSITION. REFERENCE DRAWING 24590-LAW-M7-LPH-00001007.
12. LMP-DI-1404 ON DRAWING 24590-LAW-M6-LMP-00002002 IS BACK UP TO CALCULATING ALTERNATE LEVEL IN LMP-LI-1131.
13. INDIVIDUAL WEST DISCHARGE CHAMBER TEMPERATURE INDICATORS HAVE HIGH ALARMS ON RATE OF CHANGE AND ON DIFFERENTIAL FROM AVERAGE WEST DISCHARGE CHAMBER TEMPERATURE.
14. POWER SUPPLY SEPARATELY CONTROLS BOTH THE EAST AND WEST DISCHARGE CHAMBERS.
15. FOR VENDOR DETAILS DRAWING, SEE VENDOR DRAWING 24590-CM-POA-EY00-00002-03-00005.
16. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00010 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00022 AND -00060.
17. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00089, -00104, AND -00105. UPDATED REFERENCE 1 AND ADR REVISION.
18. REVISION 2: ADDED BALL VALVES TO ALIGN WITH VENDOR DRAWINGS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00010001	LAW MELTER PROCESS SYSTEM MELTER 1 DISCHARGE HEATERS, POWER CONTROLS (1-4) AND AIR LIFT-WESTSIDE

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 18	VC	MHS	KDJ	Cmw AC TRV	9/11/19
1	REVISED PER NOTE 17	BLR	TM	N/A	AL/CN/TV	6/04/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 16	MP	APP	SK/SS	RS/JS	8/30/10

REVISION HISTORY

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/23/10
CHECKER	PINTO, PAT	8/23/10
APPROVER	STEVENS,R/SCHNEIDER,J	8/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 1 DISCHARGE HEATERS, POWER CONTROLS (1 - 4) AND AIR LIFT - WESTSIDE

SCALE: NONE
24590-LAW-M6-LMP-00010001
REV 2

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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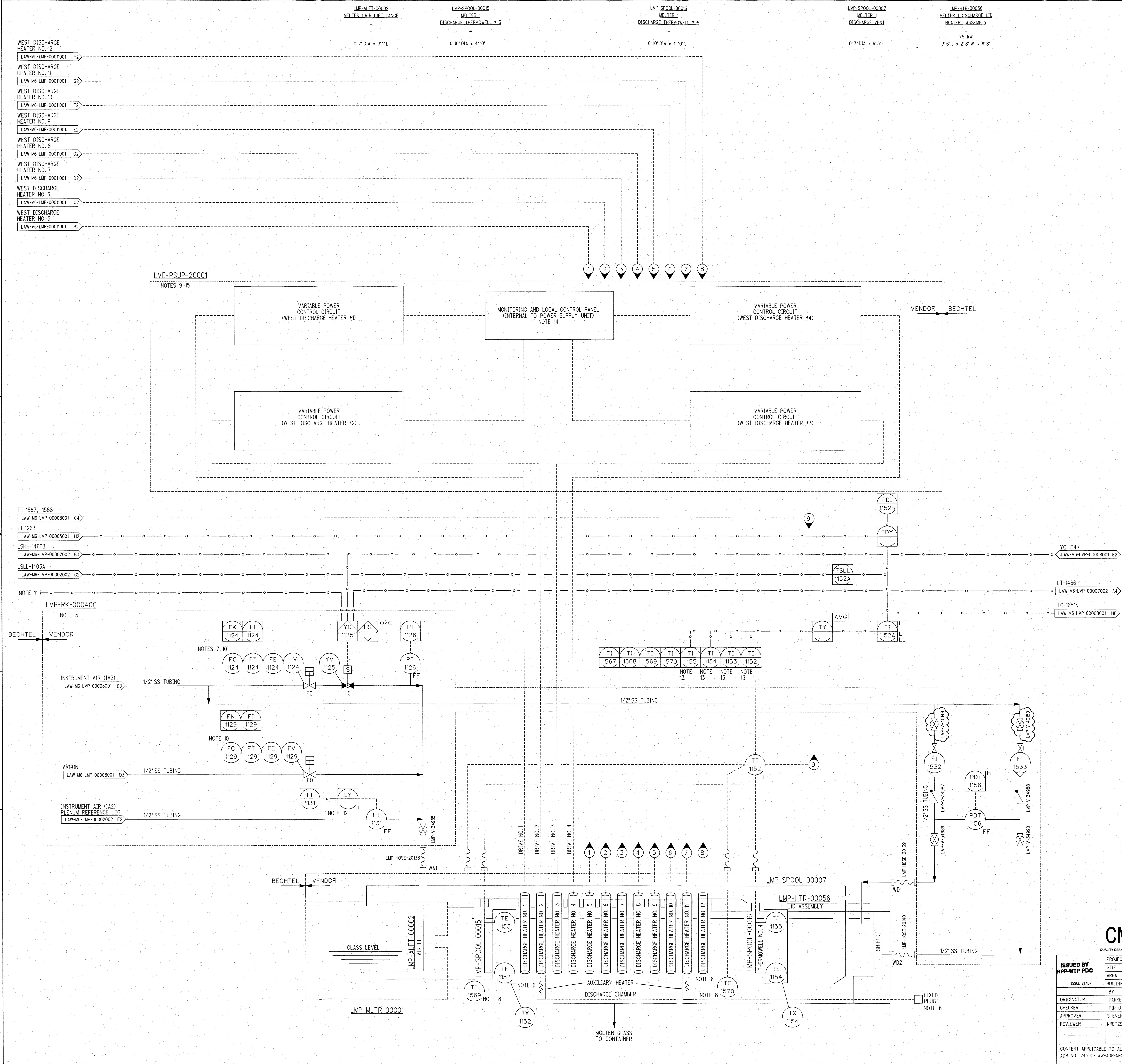

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS ON THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. ALL INSTRUMENTS AND VALVING FOR AIR LIFT SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE SHIELD WALL TO REDUCE LINE CAPACITANCE AND AIR LIFT SURGING.
6. DISCHARGE AUXILIARY HEATERS PREWIRED TO PLUG FOR USE, AS REQUIRED BY OPERATIONS.
7. WHEN VALVE LMP-YV-1125 IS NOT OPEN, SETPOINT TO LMP-FC-1124 IS FORCED TO ZERO PERCENT.
8. TE-1569 AND TE-1570 ARE INTEGRAL WITH AUXILIARY HEATER AND ARE NOT REPLACEABLE.
9. FOR ELECTRICAL SUPPLY DESIGN SEE DRAWING 24590-LAW-E1-LVE-00031.
10. FLOW CONTROL (FC) IS INTEGRAL TO THE VALVE. ACTUAL SETPOINT PROVIDED FROM ICN.
11. HIGH HIGH CONTAINER WEIGHT (LPH-WE-3505A/B) CLOSES VALVE LMP-YV-1125 TO STOP POUR AND PREVENT CONTAINER OVERFILL. CONTAINER WEIGHT (LPH-WE-3505A/B) AND POSITION (LPH-ZS-3501) PREVENTS GLASS POURING WHEN A CONTAINER IS NOT IN POURING POSITION. REFERENCE DRAWING 24590-LAW-M7-LPH-00001007.
12. LMP-DI-1404 ON DRAWING 24590-LAW-M6-LMP-00002002 IS BACK UP TO CALCULATING ALTERNATE LEVEL IN LMP-LI-1131.
13. INDIVIDUAL WEST DISCHARGE CHAMBER TEMPERATURE INDICATORS HAVE HIGH ALARMS ON RATE OF CHANGE AND ON DIFFERENTIAL FROM AVERAGE WEST DISCHARGE CHAMBER TEMPERATURE.
14. POWER SUPPLY SEPARATELY CONTROLS BOTH THE EAST AND WEST DISCHARGE CHAMBERS.
15. FOR VENDOR DETAILS DRAWING, SEE VENDOR DRAWING 24590-CM-POA-EY00-00002-03-00005.
16. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00010 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00022 AND -00060.
17. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00089, -00104, AND -00105. UPDATED REFERENCE 1 AND ADR REVISION.
18. REVISION 2: ADDED BALL VALVES TO ALIGN WITH VENDOR DRAWINGS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00010001	LAW MELTER PROCESS SYSTEM MELTER 1 DISCHARGE HEATERS, POWER CONTROLS (1-4) AND AIR LIFT-WESTSIDE

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 18	VC	MHS		JTW	9/4/19
1	REVISED PER NOTE 17	BLR	TM	N/A	AL/CN/TV	6/04/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 16	MP	APP	SK/SS	RS/JS	8/30/10

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/23/10
CHECKER	PINTO, PAT	8/23/10
APPROVER	STEVENS,R/SCHNEIDER,J	8/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	8/25/10

BECHTEL

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 1 DISCHARGE HEATERS, POWER CONTROLS (1 - 4) AND AIR LIFT - WESTSIDE

CONTENT APPLICABLE TO ALARA? X YES NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

SCALE: NONE
24590-LAW-M6-LMP-00010001
REV 2

"E" SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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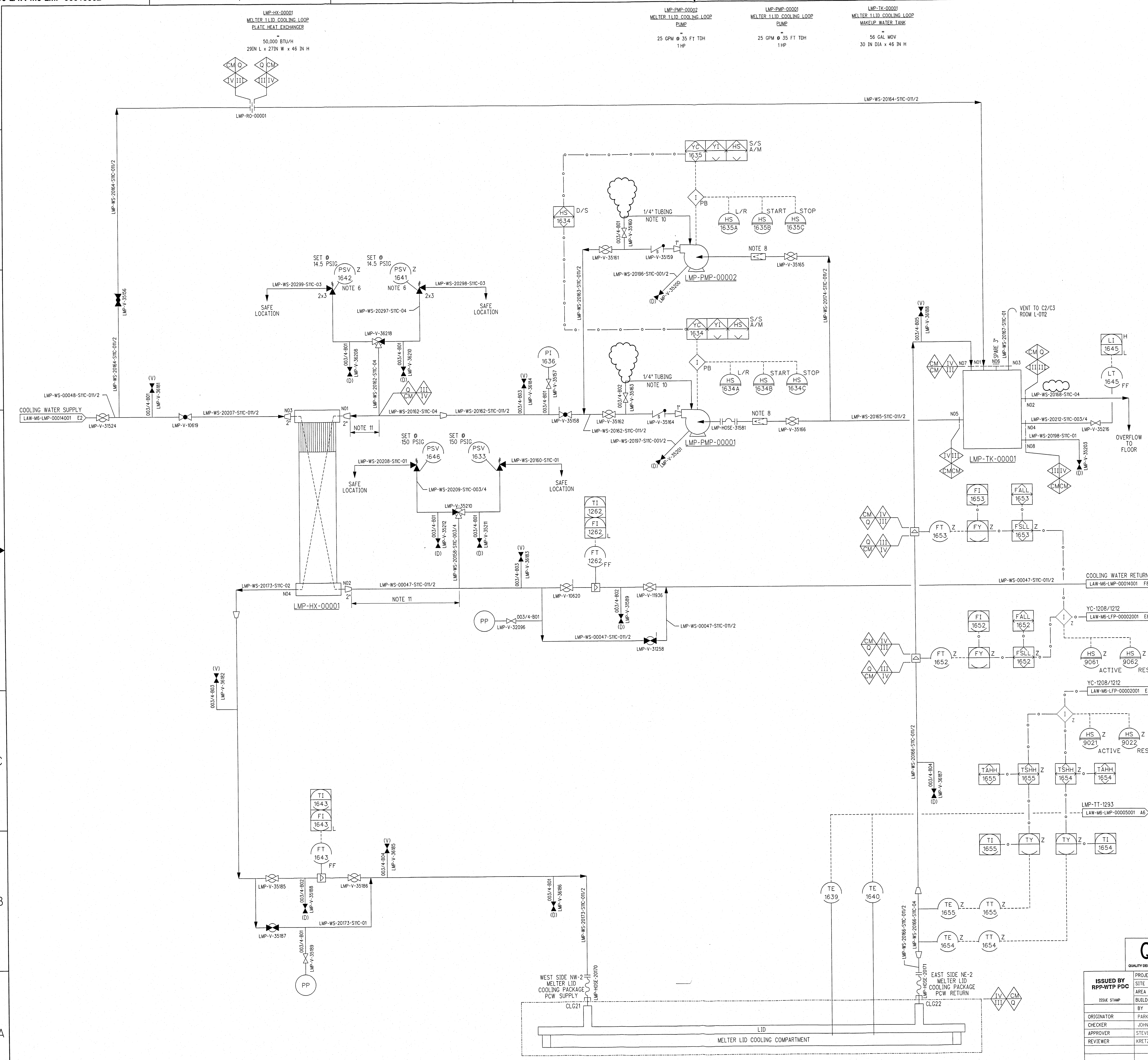

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. DELETED
6. SETPOINT AND PHYSICAL LOCATION OF PSV PREVENTS OVERPRESSURE IN GAS BARRIER LID COOLING COMPARTMENT.
7. DELETED
8. PROVIDE REMOVABLE PIPING SPOOL FOR STARTUP STRAINER, STRAINER WILL BE REMOVED PRIOR TO STARTUP.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET DRAWING TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00013 REV 6. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00005, -00042, -00071, -00075, 24590-LAW-M6N-20-00003, 24590-WTP-SDDR-ML-09-00035, AND 24590-WTP-SDDR-MS-10-00024.
10. CONSTRUCTION SHALL FIELD ROUTE TUBING FROM INDICATED LOCATION ON PIPE TO FLUSH PORT ON VENDOR SUPPLIED PUMP SHAFT SEAL. REFER TO MECHANICAL SYSTEMS TUBING DETAIL 24590-WTP-M0-50-00083.
11. DISTANCE FROM HEAT EXCHANGER NOZZLE TO BRANCH FOR PSV NOT TO EXCEED 3 FEET.
12. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00081, -00091, 00103, 24590-WTP-FC-M-14-0036, 24590-WTP-FC-P-15-0062, AND 24590-LAW-EIE-NS-17-0001 REV 0. CHANGES ASSOCIATED WITH 24590-LAW-EIE-NS-17-0001 REV 0 WERE OVERCOME BY DSA DRIVEN CHANGES CONTAINED IN 24590-LAW-M6N-LMP-00103. REVISED REFERENCES AND ADR REVISION NUMBER.
13. REVISION 2: DELETED NOTE 5 IN RESPONSE TO 24590-WTP-FC-P-18-0173. DELETED PP FROM LMP-PMP-00001 AND LMP-PMP-00002, WHICH CORRECTED OMISSION FROM 24590-WTP-FC-P-15-0062 IN PREVIOUS REVISION.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS SYSTEM DESIGN DESCRIPTION.

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 13	DJK	SJ	KRS	CMN	9/19/18
1	REVISED PER NOTE 12	LV	DJA	KRS	AC/RB/JL	07/12/18
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	MP	NJ	SK/SS	RS/JS	08/30/10

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/18/10
CHECKER	JOHNSON, NGA T	08/19/10
APPROVER	STEVENS,R/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	08/25/10

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM
MELTER 1
MELTER LID
COOLING LOOP

R11920332

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

SCALE: NONE

24590-LAW-M6-LMP-00013002 REV 2

DESIGN CHANGES INCORPORATED BY REFERENCE:

DOCUMENT NUMBER	24590-WTP-FC-M-12-0250

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

WHEN REFERENCING DRAWING AND DIM NUMBERS IN DOCUMENTS, BE SURE TO INCLUDE DASHES BETWEEN ELEMENTS

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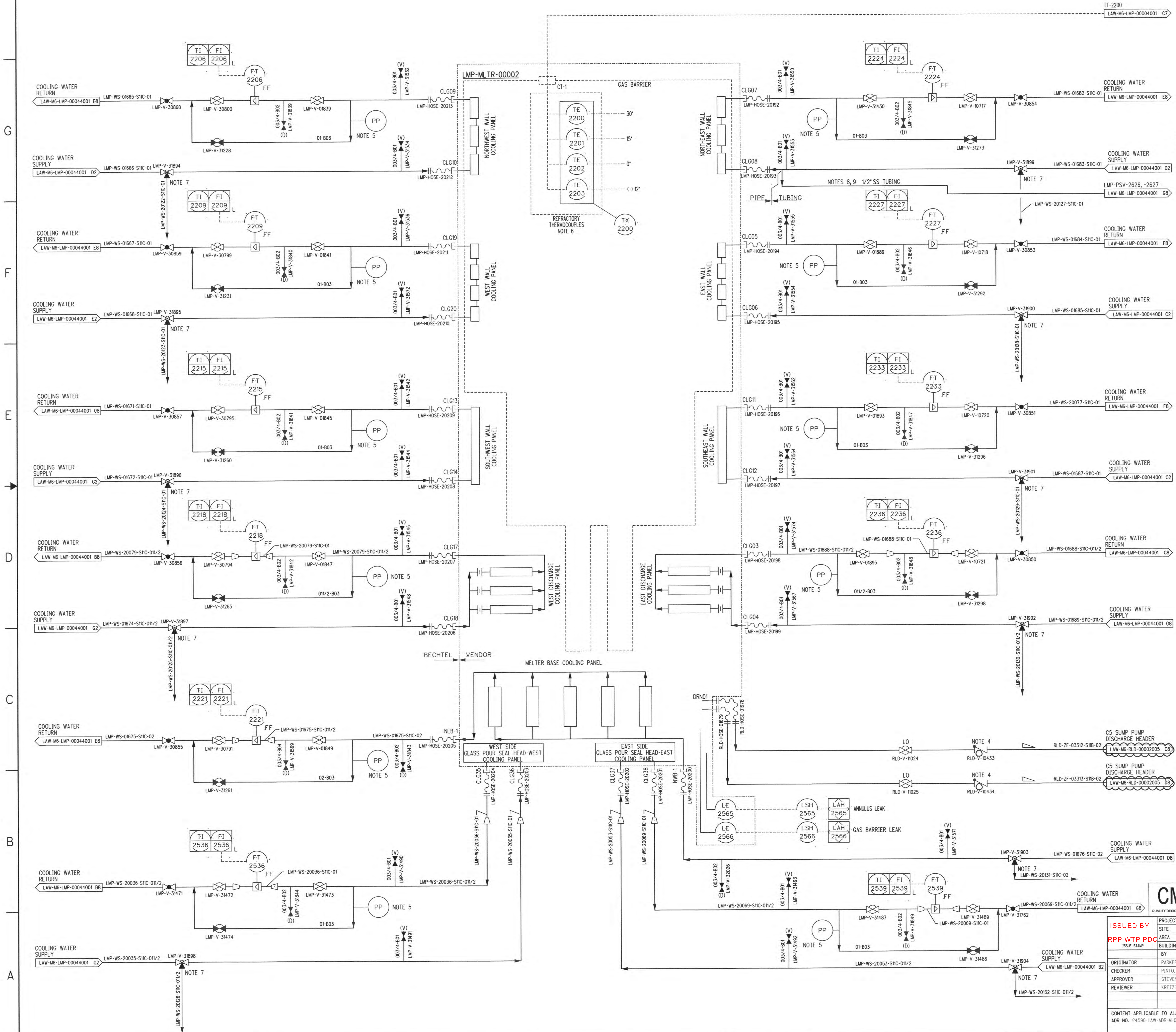
24590-LAW-M6-LMP-00033001



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. REMOVE SPRING FROM PISTON CHECK VALVE AND INSTALL IN HORIZONTAL PIPING.
5. CONNECTIONS FOR PP'S ARE 1/2" THREADED, THIS CONNECTION FOR TEMPORARY INSTRUMENT WILL BE PLUGGED AFTER TEST.
6. REFRACTORY THERMOCOUPLE LOCATIONS ARE RELATIVE TO REFRACTORY FLOOR.
7. 3-WAY VALVE BLEED LINE TO BE ROUTED TOWARDS SAFE LOCATION. SUPPLY SIDE CLOSES WHEN BLEED OPENS.
8. TUBING IS REMOTE SENSING LINE FOR LMP-PSV 2626, 2627.
9. CONSTRUCTION SHALL FIELD ROUTE TUBING FROM PSV SENSING LINE PORT TO COOLING WATER SUPPLY PIPING NEAR CONNECTION CLG08 MECHANICAL SYSTEMS CONNECTION DETAIL SERIES 24590-WTP-M0-50-00074 DRAWING WILL DEFINE ROUTING.
10. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00033 REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00009, -00022, -00033, -00043, 24590-LAW-M6PN-LMP-00006, AND 24590-LAW-M6PR-LMP-00001.
11. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00055 AND -00102. UPDATED REFERENCE, ADR REVISION AND OFF SHEET CONNECTORS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00033001	LAW MELTER PROCESS SYSTEM COOLING SYSTEM

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 11	BCR	JM	N/A	AML Gow TRV	6/4/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	8/30/10

REVISION HISTORY

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/17/10
CHECKER	PINTO, PAT	8/18/10
APPROVER	STEVENS, ROBERT	8/30/10
REVIEWER	KRETZSCHMAR, STUART	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 2 WALLS AND FLOOR PANELS COOLING SYSTEM

SCALE: NONE
24590-LAW-M6-LMP-00033001
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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5/30/2019 8:08:21 AM

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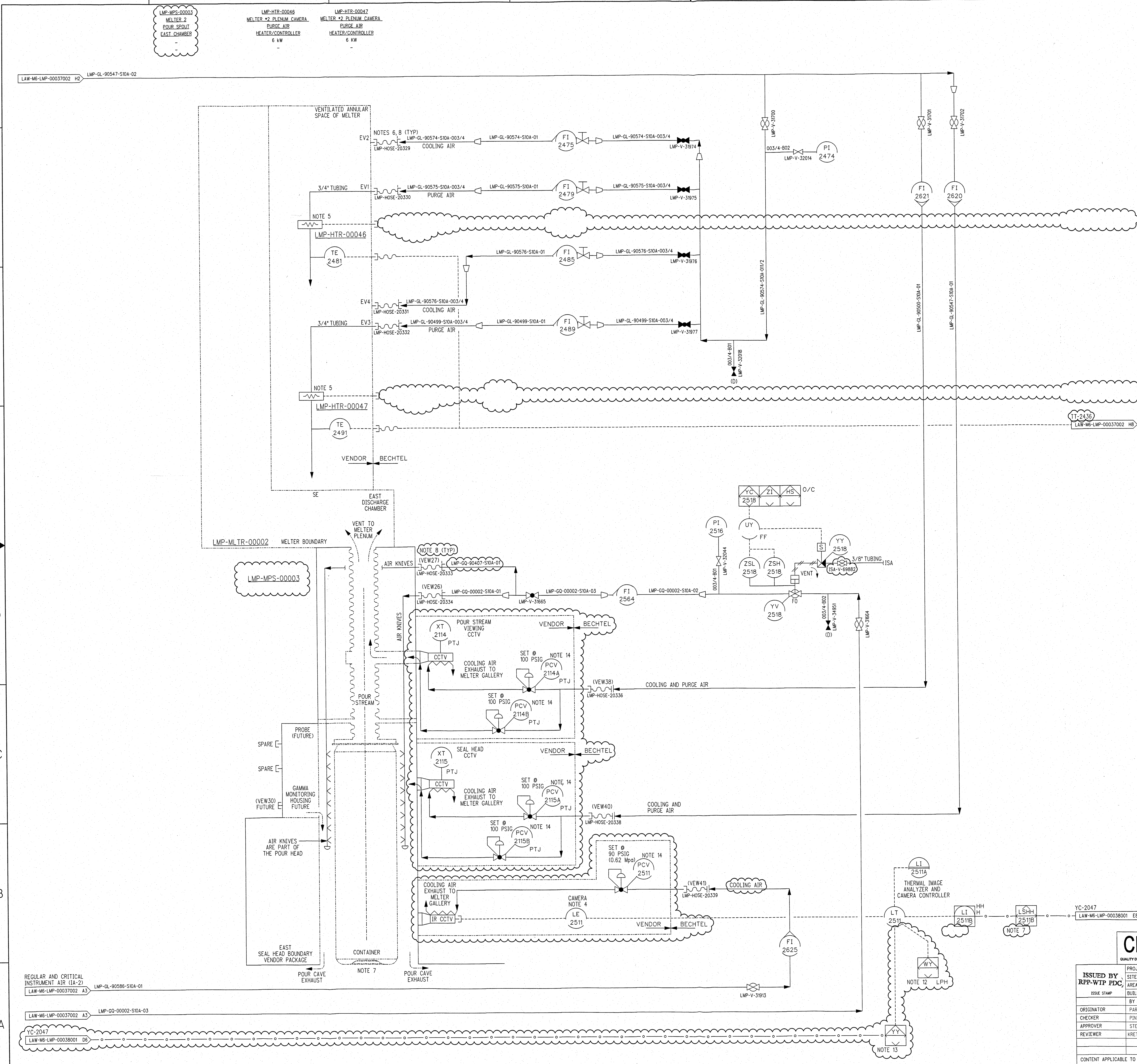
FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. THE IR CAMERA DETECTS GLASS LEVEL (THERMAL TRANSITION REGION) ON CONTAINER.
5. AIR PRE-HEAT FOR FUTURE CCTV VIEW PORT.
6. AIR FOR FUTURE PLENUM CCTV.
7. HIGH HIGH LEVEL FROM THE THERMAL IMAGE SYSTEM AUTOMATICALLY SHUTS DOWN THE MELTER DISCHARGE.
8. SERVICE SIDE OF FLEX CONNECTION IS FEMALE CAMLOCK BY PLANT EQUIPMENT GROUP.
9. DELETED
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00037 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00035, AND -00062.
11. DELETED
12. DISCRETE OUTPUT TO LMP-LT-2511 INDICATING CONTAINER PRESENT (LPH-WE-5205A/B) AND IN POUR POSITION (LPH-ZS-5201). REFERENCE 24590-LAW-M7-LPH-00001013.
13. DISCRETE OUTPUT TO LMP-LT-2511 INDICATING GLASS IS POURING WHEN LMP-YV-2047 VALVE IS COMMANDED OPEN.
14. PCV HAS INTEGRAL INDICATOR.
15. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-M80T-00016, 24590-LAW-M6N-LMP-00083, -00090, -00094, AND -00105. DELETED PSUP AND NOTE 11 IN RESPONSE TO 24590-WTP-FC-E-18-0536. UPDATED REFERENCE 1 AND ADR REVISION.

HOLD/OPEN ITEMS:

1. DELETED

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00037001	MELTER PROCESS SYS MONITORING INSTRUMENTATION
24590-LAW-M6-LMP-00037002	MELTER PROCESS SYS MONITORING INSTRUMENTATION

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 15	DJA	BWJ	KRJ	RAS AC TRV	4/12/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	08/30/10

REVISION HISTORY

CM
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/17/10
CHECKER	PINTO, PAT	08/18/10
APPROVER	STEVENS,S/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	08/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 2 GLASS POURING AND MONITORING INSTRUMENTATION

SCALE: NONE

24590-LAW-M6-LMP-00037001 REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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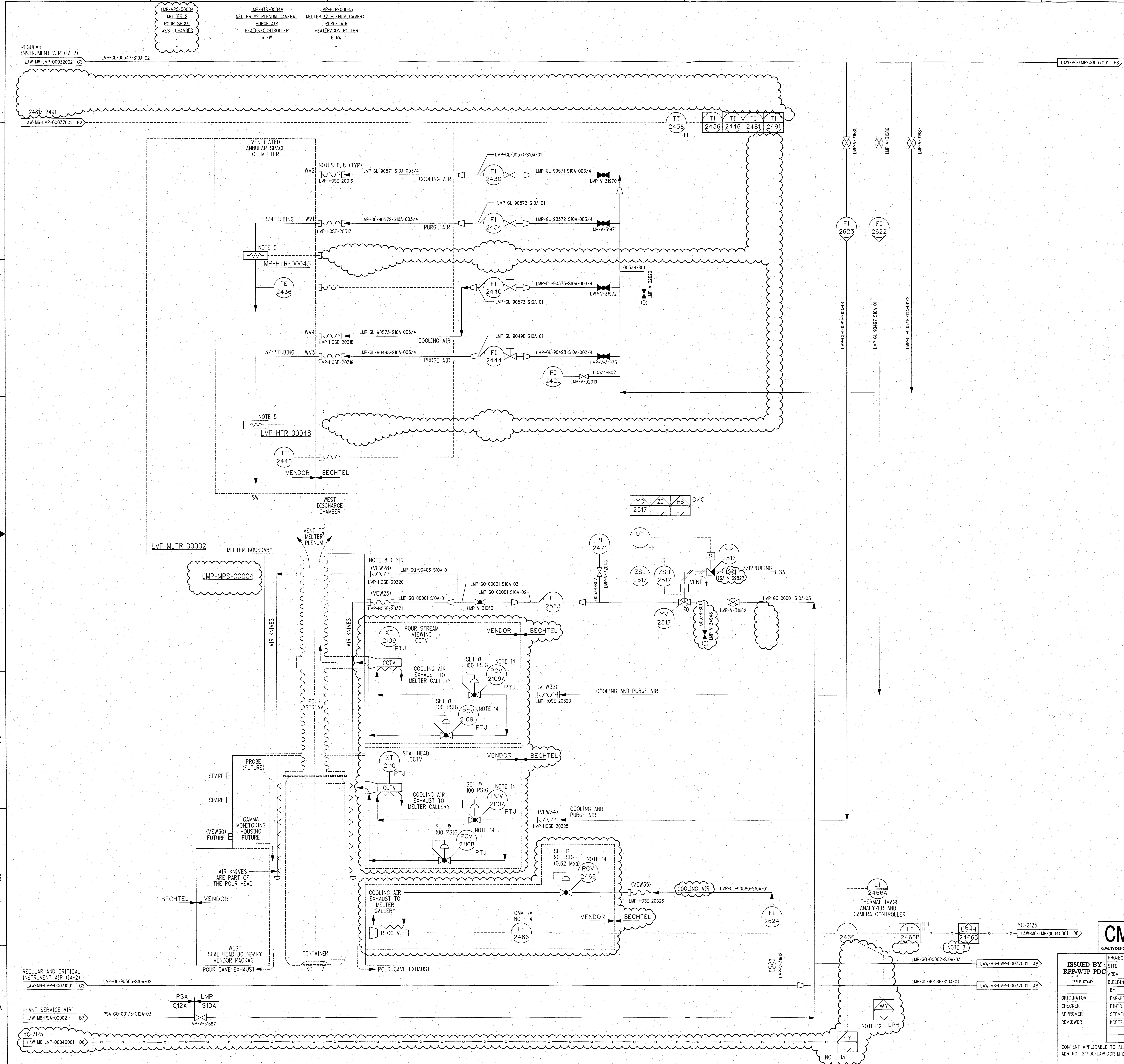

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. THE IR CAMERA DETECTS GLASS LEVEL (THERMAL TRANSITION REGION) ON CONTAINER.
5. AIR PRE-HEATER FOR FUTURE CCTV VIEWPORT.
6. AIR FOR FUTURE PLENUM CCTV.
7. HIGH HIGH LEVEL FROM THE THERMAL IMAGE SYSTEM AUTOMATICALLY SHUTS DOWN THE MELTER DISCHARGE.
8. SERVICE SIDE OF FLEX CONNECTION IS FEMALE CAMLOCK BY PLANT EQUIPMENT GROUP.
9. DELETED
10. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00037 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00035, AND -00057.
11. DELETED
12. DISCRETE OUTPUT TO LMP-LT-2466 INDICATING CONTAINER PRESENT (LPH-WE-4605A/B) AND IN POUR POSITION (LPH-ZS-4601). REFERENCE 24590-LAW-M7-LPH-00001011.
13. DISCRETE OUTPUT TO LMP-LT-2466 INDICATING GLASS IS POURING WHEN LMP-YV-2125 VALVE IS COMMANDED OPEN.
14. PCV HAS INTEGRAL INDICATOR.
15. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-M80T-00016, 24590-WTP-FC-SU-18-0115, 24590-LAW-M6N-LMP-00090, -00094, AND -00105. DELETED PSUP AND NOTE 11 IN RESPONSE TO 24590-WTP-FC-E-18-0536. UPDATED REFERENCE 1 AND ADR REVISION.

HOLD/OPEN ITEMS:

1. DELETED

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.
2. 24590-LAW-M7-LPH-00001011, LAW VITRIFICATION SYSTEM LPH MECHANICAL HANDLING DIAGRAM CONTAINER POUR HANDLING SYSTEM.

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 15	DJA	BWJ	KRI	RPB3 AC TRV	4/12/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	08/30/10

REVISION HISTORY

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/17/10
CHECKER	PINTO, PAT	08/18/10
APPROVER	STEVENS,R/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR, STUART	08/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 2 GLASS POURING AND MONITORING INSTRUMENTATION

SCALE: NONE
24590-LAW-M6-LMP-00037002
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11924951

4/11/2019 10:21:02 AM

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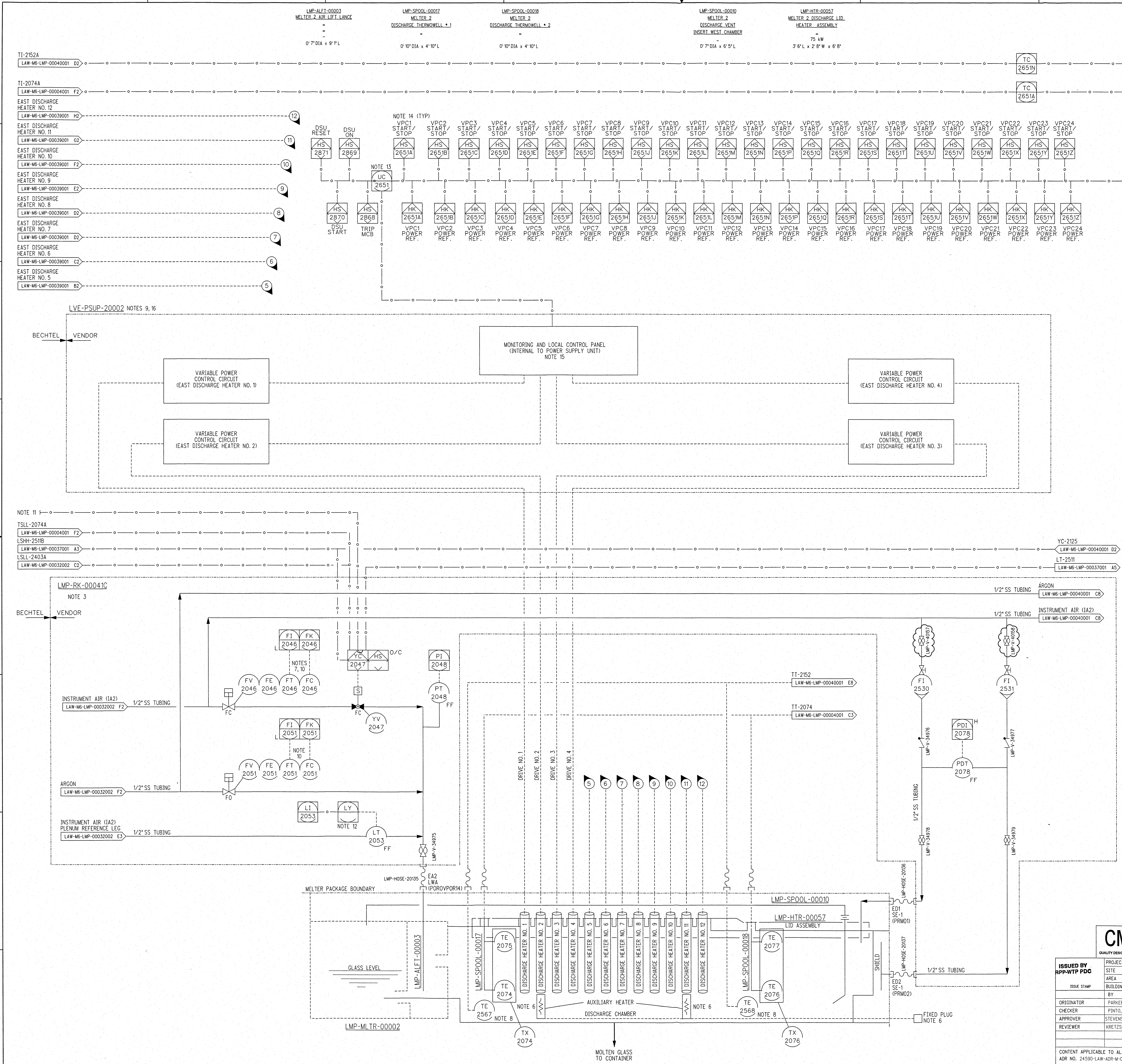

NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. ALL INSTRUMENTS AND VALVING FOR AIR LIFT SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE SHIELD WALL TO REDUCE LINE CAPACITANCE AND AIR LIFT SURGING.
6. DISCHARGE AUXILIARY HEATERS PREWIRED TO PLUG FOR USE, AS REQUIRED BY OPERATIONS.
7. WHEN VALVE LMP-YV-2047 IS NOT OPEN, SETPOINT TO LMP-FC-2046 IS FORCED TO ZERO PERCENT.
8. TE-2567 AND TE-2568 ARE INTEGRAL WITH AUXILIARY HEATER AND ARE NOT REPLACEABLE.
9. FOR ELECTRICAL SUPPLY DESIGN SEE DRAWING 24590-LAW-E1-LVE-00031.
10. FLOW CONTROL (FC) IS INTEGRAL TO THE VALVE. ACTUAL SETPOINT PROVIDED FROM ICN.
11. HIGH HIGH CONTAINER WEIGHT (LPH-WE-5205A/B) CLOSES VALVE LMP-YV-2047 TO STOP POUR AND PREVENT CONTAINER OVERFILL. CONTAINER WEIGHT (LPH-WE-5205A/B) AND POSITION (LPH-ZS-5201) PREVENTS GLASS POURING WHEN A CONTAINER IS NOT IN POURING POSITION. REFEENCE DRAWING 24590-LAW-M7-LPH-00001013.
12. LMP-DI-2404 ON DRAWING 24590-LAW-M6-LMP-00032002 IS USED IN CALCULATION OF ALTERNATE LEVEL LMP-LI-2053.
13. DISCHARGE HEATER POWER SUPPLY OPERATION IS INITIATED AND OPERATIONAL STATUS IS MONITORED FROM THE FACILITY CONTROL SYSTEM. TAG REPRESENTS MULTIPLE CONTROL AND INDICATING PARAMETERS FOR ALL EAST AND WEST DISCHARGE CHAMBER HEATERS AVAILABLE TO FACILITY OPERATOR. CONTROL SIGNAL ORIGINATES FROM AVERAGE DISCHARGE CHAMBER TEMPERATURES.
14. EACH HEATER VPC HAS A START/STOP HAND SWITCH AND A POWER REFERENCE AUTO/MANUAL STATION. EAST CHAMBER HEATERS ARE VPC1 THROUGH VPC12. WEST CHAMBER HEATERS ARE VPC13 THROUGH VPC24.
15. POWER SUPPLY SEPARATELY CONTROLS BOTH THE EAST AND WEST DISCHARGE CHAMBERS.
16. FOR PACKAGE DETAILS, SEE DRAWING 24590-CM-POA-EY00-00002-03-00005.
17. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00038 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00022, AND -00063.
18. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00089, -00104, AND -00105. UPDATED REFERENCE 1, ADR REVISION, AND EQUIPMENT TAG NUMBER.
19. REVISION 2: ADDED BALL VALVES TO ALIGN WITH VENDOR DRAWINGS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00038001	LAW MELTER PROCESS SYSTEM

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 19	VL	MHS	RAS		9/4/19
1	REVISED PER NOTE 18	BLR	TM	N/A	AL/CN/TV	06/04/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 17	MP	APP	SK/SS	RS/JS	08/30/10

CM QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC

ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/26/10
CHECKER	PINTO, PAT	8/26/10
APPROVER	STEVENS, R/SCHNEIDER, J	8/30/10
REVIEWER	KRETZSCHMAR, S/SMITH, S	8/26/10

BECHTEL

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW LAW MELTER PROCESS SYSTEM MELTER 2 DISCHARGE HEATERS, POWER CONTROLS (1 - 4) AND AIR LIFT - EASTSIDE

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

SCALE: NONE

24590-LAW-M6-LMP-00038001 REV 2

"E" SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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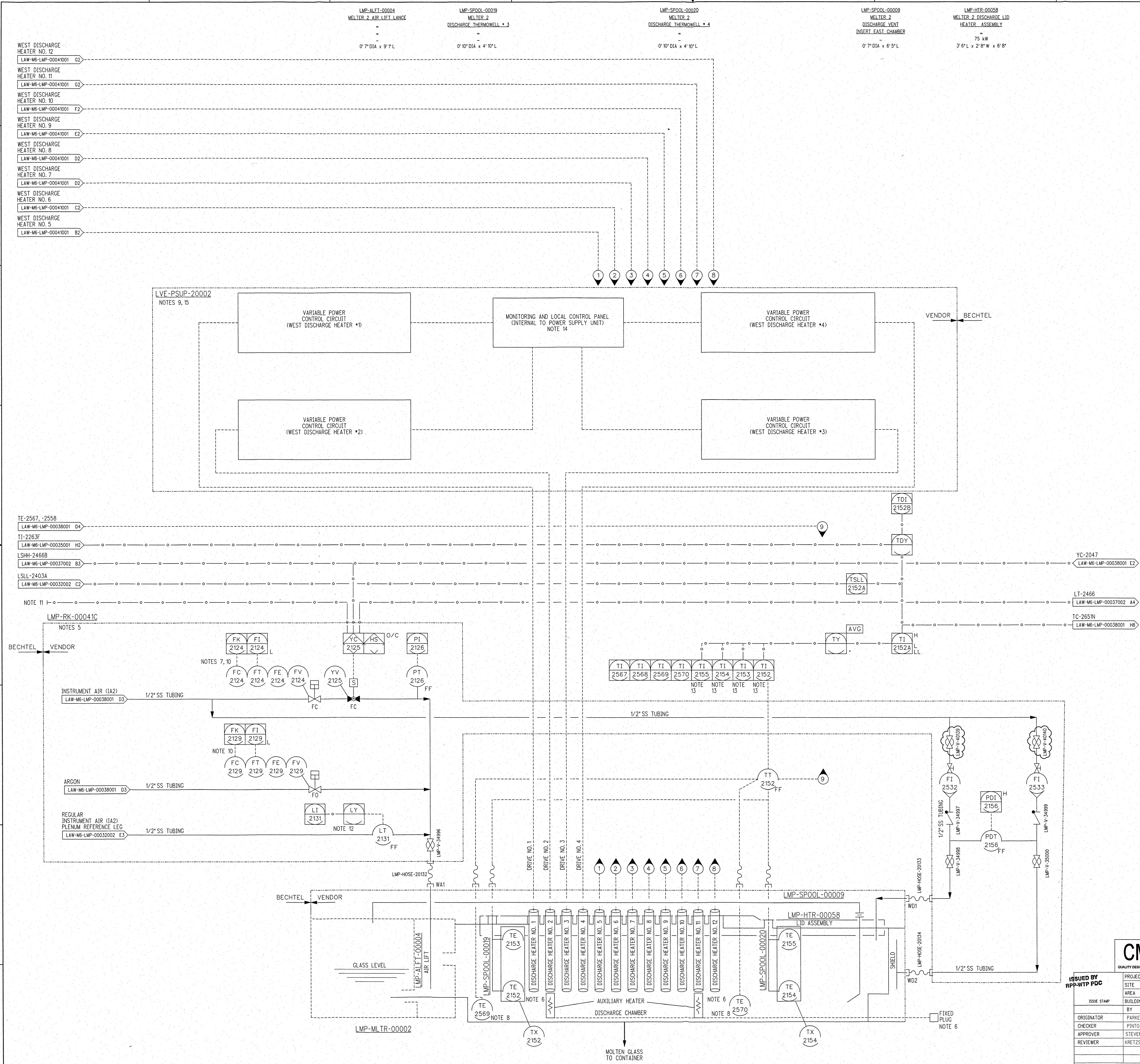


NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING, UNLESS OTHERWISE NOTED.
5. ALL INSTRUMENTS AND VALVING FOR AIR LIFT SHOULD BE LOCATED AS CLOSE AS POSSIBLE TO THE SHIELD WALL TO REDUCE LINE CAPACITANCE AND AIR LIFT SURGING.
6. DISCHARGE AUXILIARY HEATERS PREWIRED TO PLUG FOR USE, AS REQUIRED BY OPERATIONS.
7. WHEN VALVE LMP-YV-2125 IS NOT OPEN, SETPOINT TO LMP-FC-2124 IS FORCED TO ZERO PERCENT.
8. TE-2569 AND TE-2570 ARE INTEGRAL WITH AUXILIARY HEATERS AND ARE NOT REPLACEABLE.
9. FOR ELECTRICAL SUPPLY DESIGN SEE DRAWING 24590-LAW-E1-LVE-00033.
10. FLOW CONTROL (FC) IS INTEGRAL TO THE VALVE. ACTUAL SETPOINT PROVIDED FROM ICN.
11. HIGH HIGH CONTAINER WEIGHT (LPH-WE-4605A/B) CLOSES VALVE LMP-YV-2125 TO STOP POUR AND PREVENT CONTAINER OVERFILL. CONTAINER WEIGHT (LPH-WE-4605A/B) AND POSITION (LPH-ZS-4601) PREVENTS GLASS POURING WHEN A CONTAINER IS NOT IN POURING POSITION. REFERENCE DRAWING 24590-LAW-M7-LPH-00001011.
12. LMP-DI-2404 ON DRAWING 24590-LAW-M6-LMP-00032002 IS BACK UP TO CALCULATING ALTERNATE LEVEL IN LMP-LI-2131.
13. INDIVIDUAL WEST DISCHARGE CHAMBER TEMPERATURE INDICATORS HAVE HIGH ALARMS ON RATE OF CHANGE AND ON DIFFERENTIAL FROM AVERAGE WEST DISCHARGE CHAMBER TEMPERATURE.
14. POWER SUPPLY SEPARATELY CONTROLS BOTH THE EAST AND WEST DISCHARGE CHAMBERS.
15. FOR PACKAGE DETAILS SEE DRAWING, 24590-CM-POA-EY00-00002-03-00005.
16. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00040 REV 4. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00022 AND -00065.
17. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00089, -00104, AND -00105. UPDATED REFERENCE 1, DRAWING INDEX, AND ADR REVISION.
18. REVISION 2: ADDED BALL VALVES TO ALIGN WITH VENDOR DRAWINGS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX

DWG NO	TITLE
24590-LAW-M6-LMP-00040001	LAW MELTER PROCESS SYSTEM MELTER 2 DISCHARGE HEATERS, POWER CONTROLS (1-4) AND AIR LIFT-WESTSIDE

CM
QUALITY DESIGNATOR

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 18	VC	MHS	KDS	TRV	9/11/19
1	REVISED PER NOTE 17	BLR	TM	N/A	AL/CN/TV	6/04/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 16	MP	APP	SK/SS	RS/JS	8/30/10

REVISION HISTORY

ISSUED BY RPP-WTP PDC

ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

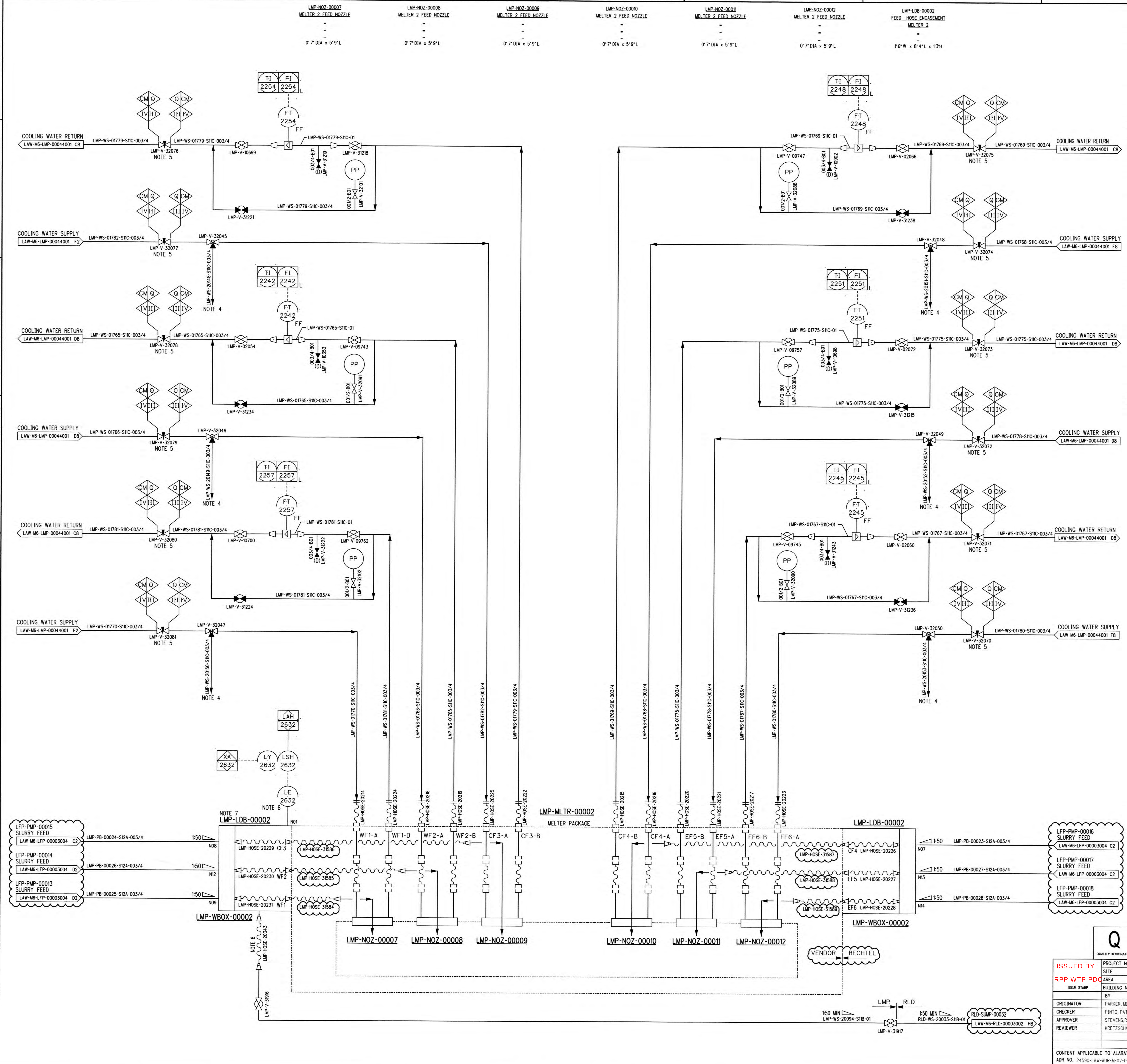
CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/23/10
CHECKER	PINTO, PAT	8/23/10
APPROVER	STEVENS,R/SCHNEIDER,J	8/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 2 DISCHARGE HEATERS, POWER CONTROLS (1 - 4) AND AIR LIFT - WESTSIDE

SCALE: NONE
224590-LAW-M6-LMP-00040001
REV 2



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. 3-WAY VALVE BLEED LINE TO BE ROUTED TOWARD SAFE LOCATION. SUPPLY SIDE CLOSES WHEN BLEED OPENS.
5. VALVE SETTING SHALL LIMIT FLOW TO MELT POOL IN THE EVENT OF A BREACH IN THE COOLING JACKET OF THE FEED NOZZLE. VALVES SHALL BE SET FOR PRESCRIBED FLOW RATE THEN ADMINISTRATIVELY CONTROLLED IN THIS POSITION. VALVE IS PURCHASED BY MECHANICAL SYSTEMS PER 24590-CM-MRA-PV21-00004.
6. COUPLING HAS ONE SHUTOFF VALVE INTEGRAL TO THE SOCKET AND ONE INTEGRAL TO THE PLUG. BOTH VALVES CLOSE WHEN COUPLING IS DISCONNECTED.
7. THE LEAK DETECTION BOX PROVIDES SECONDARY CONTAINMENT AROUND THE LAW FEED HOSES AND DIRECTS ANY RELEASE TO THE CELL SUMP. THIS PIECE OF EQUIPMENT WAS GIVEN THE EQUIPMENT DESIGNATOR LDB, LEAK DETECTION BOX, BECAUSE THERE IS NOT A DESIGNATOR FOR A MELTER FEED HOSE ENCASEMENT ASSEMBLY.
8. LE-2632 IS A CABLE TYPE CONDUCTIVITY LEVEL DETECTION ELEMENT.
9. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00042 REV 6. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6-LMP-00010, -00032, -00033, -00038, -00048, -00071, 24590-LAW-M6PN-LMP-00006, AND 24590-LAW-M6N-M80T-00004.
10. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00109 AND ADDED BECHTEL/VENDOR BOUNDARY. UPDATED OFF SHEET CONNECTORS, ADR REVISION, DRAWING INDEX, REFERENCE 1, AND NOTE 5.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS (LMP) SYSTEM DESIGN DESCRIPTION.

DRAWING INDEX	
DWG NO	TITLE
24590-LAW-M6-LMP-00042001	LAW MELTER PROCESS SYSTEM MELTER 2 FEED NOZZLES COOLING SYSTEM AND FEED NOZZLES

REVISION HISTORY

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 10	BCK	TM	N/A	AML TRV	6/4/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	MP	APP	SK/SS	RS/JS	8/30/10

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/23/10
CHECKER	PINTO, PAT	8/23/10
APPROVER	STEVENS,R/SCHNEIDER,J	8/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM MELTER 2 FEED NOZZLES COOLING SYSTEM AND FEED NOZZLES

SCALE: NONE
24590-LAW-M6-LMP-00042001
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

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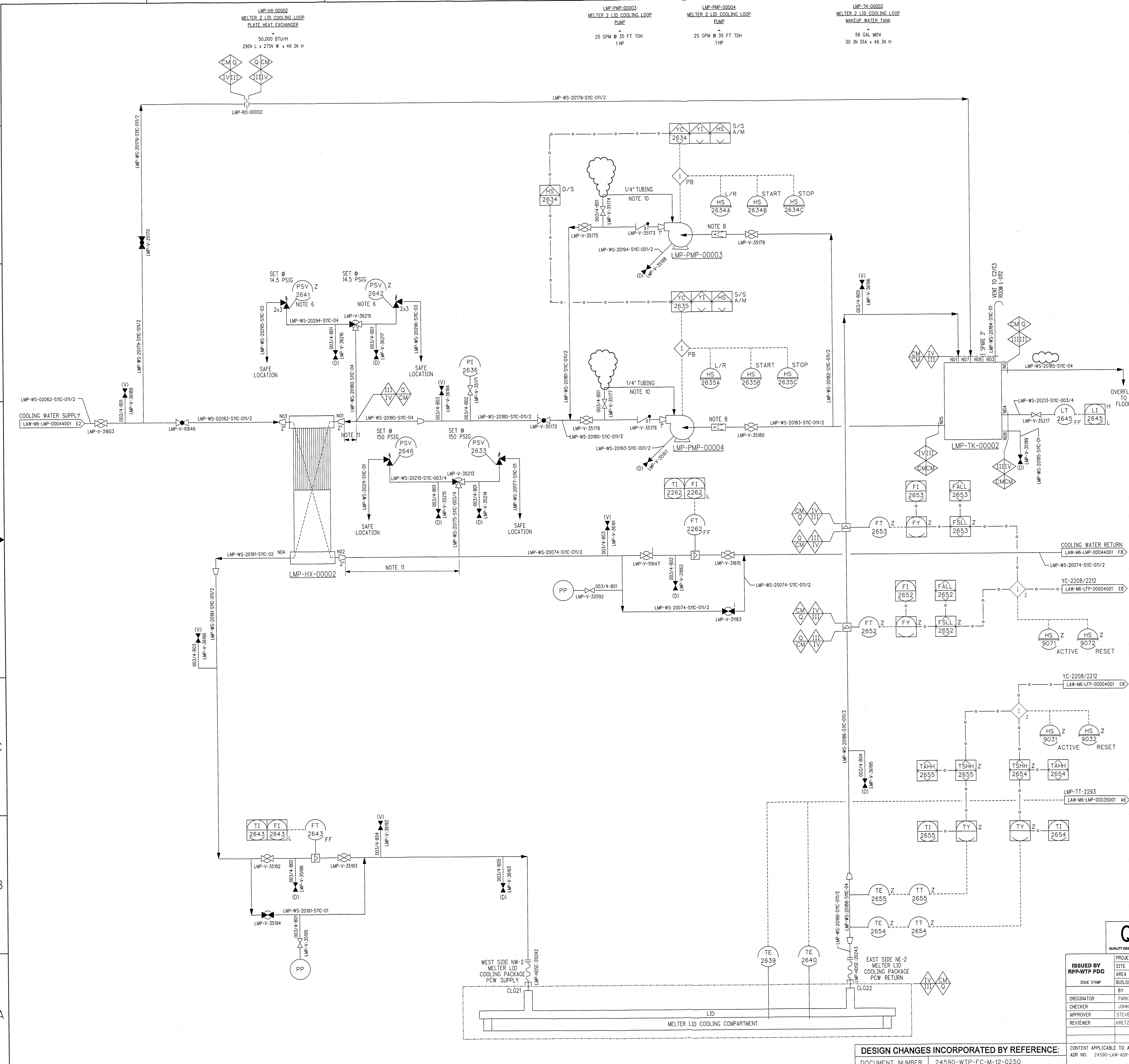
FORM E_SDN.DGN 02/2009

PLOTTED BY: mthawkin c:\work\mthawkin\dms03838\LAWM6LMP00042001.dgn



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS ON THIS DRAWING IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. ALL LINES SHOWN ON THIS DRAWING SHALL BE FREE DRAINING UNLESS OTHERWISE NOTED.
5. DELETED
6. SETPOINT AND PHYSICAL LOCATION OF PSV PREVENTS OVERPRESSURE IN GAS BARRIER LID COOLING COMPARTMENT.
7. DELETED
8. PROVIDE REMOVABLE PIPING SPOOL FOR STARTUP STRAINER, STRAINER WILL BE REMOVED PRIOR TO STARTUP.
9. THIS DRAWING IS CONVERTED FROM A SINGLE SHEET DRAWING TO MULTI-SHEET DRAWINGS AND, IN PART, SUPERSEDES 24590-LAW-M6-LMP-00043 REV 6. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00044, -00071, -00075, -00005, AND 24590-LAW-M6N-20-00003, 24590-WTP-SDDR-ML-09-00035, AND 24590-WTP-SDDR-MS-10-00024.
10. CONSTRUCTION SHALL FIELD ROUTE TUBING FROM INDICATED LOCATION ON PIPE TO FLUSH PORT ON VENDOR SUPPLIED PUMP SHAFT SEAL. REFER TO MECHANICAL SYSTEMS TUBING DETAIL 24590-WTP-M0-50-00083.
11. DISTANCE FROM HEAT EXCHANGER NOZZLE TO BRANCH FOR PSV NOT TO EXCEED 3 FEET.
12. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00081, -00091, -00097, -00103, 24590-WTP-FC-P-15-0062, AND 24590-LAW-EIE-NS-17-0001 REV 0. CHANGES ASSOCIATED WITH 24590-LAW-EIE-NS-17-0001 REV 0 WERE OVERCOME BY DSA DRIVEN CHANGES CONTAINED IN 24590-LAW-M6N-LMP-00103. REVISED REFERENCE AND ADR REVISION NUMBER.
13. REVISION 2: DELETED NOTE 5 IN RESPONSE TO 24590-WTP-FC-P-18-0173. DELETED PP FROM LMP-PMP-00003 AND LMP-PMP-00004, WHICH CORRECTED OMISSION FROM 24590-WTP-FC-P-15-0062 IN PREVIOUS REVISION.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS SYSTEM DESIGN DESCRIPTION.

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
2	REVISED PER NOTE 13	DJA	[illegible]	KRS	[illegible]	9/19/18
1	REVISED PER NOTE 12	LV	DJA	KRS	AC/RB/JL	07/12/18
0	ISSUED FOR CONSTRUCTION, SEE NOTE 9	MP	NJ	SK/SS	RS/JS	08/30/10

REVISION HISTORY

Q
QUALITY DESIGNATOR

ISSUED BY RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	08/18/10
CHECKER	JOHNSON, NGA T	08/19/10
APPROVER	STEVENS,R/SCHNEIDER,J	08/30/10
REVIEWER	KRETZSCHMAR,S/SMITH,S	08/25/10

P&ID - LAW
LAW MELTER PROCESS SYSTEM
MELTER 2
MELTER LID
COOLING LOOP

R11920333

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

DESIGN CHANGES INCORPORATED BY REFERENCE:

DOCUMENT NUMBER	24590-WTP-FC-M-12-0250

SCALE: NONE

24590-LAW-M6-LMP-00043002 REV 2

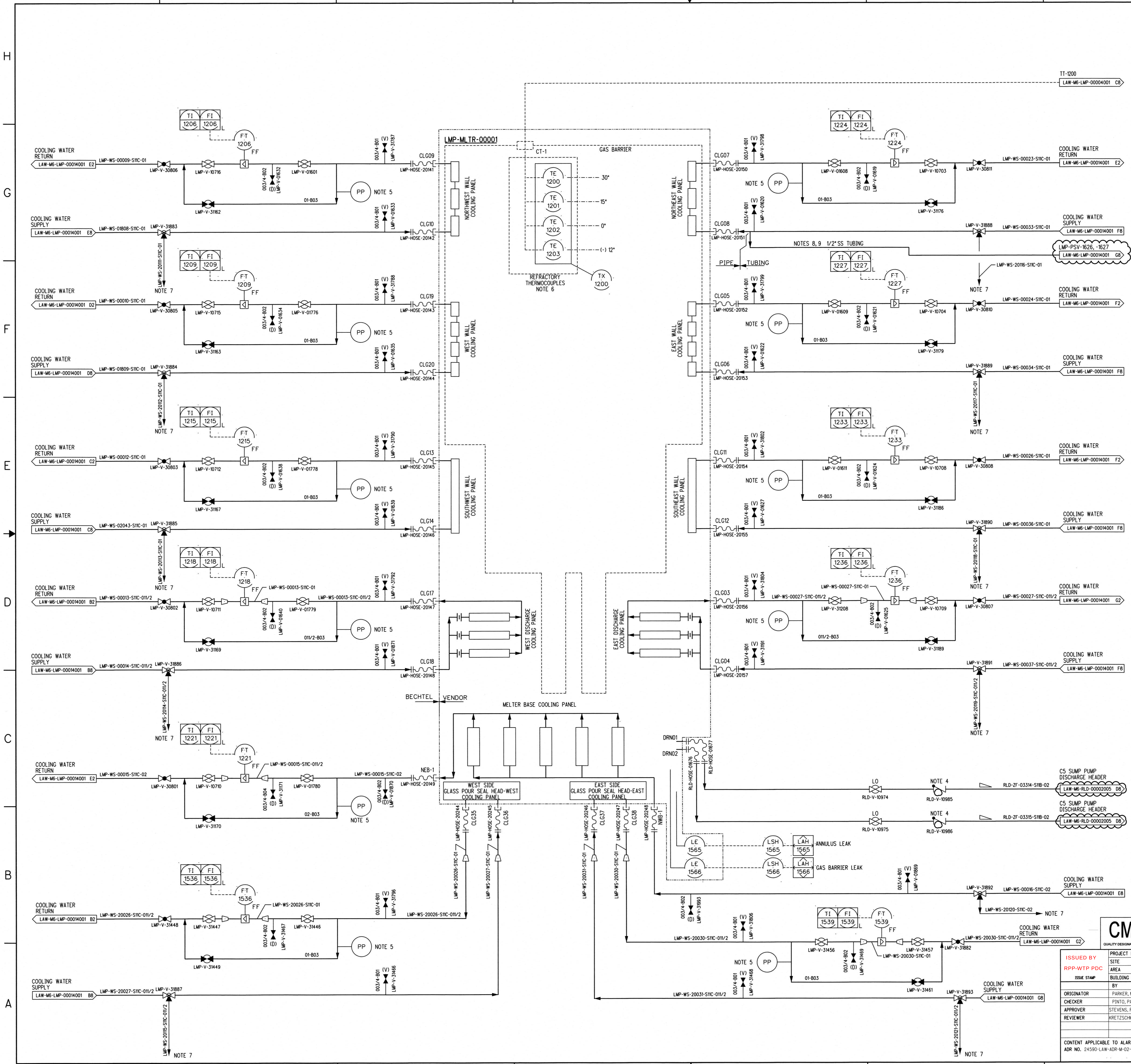
'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

WHEN REFERENCING DRAWING AND DIM NUMBERS IN DOCUMENTS, BE SURE TO INCLUDE DASHES BETWEEN ELEMENTS

9/17/2018 3:28:01 PM

c:\work\lcsanvic\dms03838\LAWM6LMP00043002.dgn
PLOTTED BY: lcsanvic

FORM E_SDN.DGN 02/2009



NOTES:

1. SEE DRAWINGS 24590-WTP-M6-50-00001 THROUGH 24590-WTP-M6-50-00008 FOR GENERAL NOTES, SYMBOLS AND LEGEND, AND GENERAL SLOPE REQUIREMENTS.
2. CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING.
3. THE PRESSURE BOUNDARY FOR ALL COMPONENTS IS QUALITY LEVEL CM AND SEISMIC CATEGORY SC-IV, UNLESS OTHERWISE NOTED.
4. REMOVE SPRING FROM PISTON CHECK VALVE AND INSTALL IN HORIZONTAL PIPING.
5. CONNECTIONS FOR PP'S ARE 1/2" THREADED. THIS CONNECTION FOR TEMPORARY INSTRUMENT WILL BE PLUGGED AFTER TEST.
6. REFRACTORY THERMOCOUPLE LOCATIONS ARE RELATIVE TO REFRACTORY FLOOR.
7. 3-WAY VALVE BLEED LINE TO BE ROUTED TOWARDS SAFE LOCATION. SUPPLY SIDE CLOSES WHEN BLEED OPENS.
8. TUBING IS REMOTE SENSING LINE FOR LMP-PSV-1626, -1627.
9. CONSTRUCTION SHALL FIELD ROUTE TUBING FROM PSV SENSING LINE PORT TO COOLING WATER SUPPLY PIPING NEAR CONNECTION CLG08. MECHANICAL SYSTEMS CONNECTION DETAIL SERIES 24590-WTP-M0-50-00074 DRAWING WILL DEFINE ROUTING.
10. THIS DRAWING SUPERSEDES 24590-LAW-M6-LMP-00003 REV 5. THIS DRAWING INCLUDES INFORMATION FROM 24590-LAW-M6N-LMP-00009, -00022, -00033, -00041, 24590-LAW-6PN-LMP-00006, AND 24590-LAW-M6PR-LMP-00001.
11. REVISION 1: INCORPORATED 24590-LAW-M6N-LMP-00055 AND -00102. UPDATED REFERENCE 1 AND OFF SHEET CONNECTORS.

HOLD/OPEN ITEMS:

NONE

REFERENCES:

1. 24590-LAW-3ZD-LMP-00001, LOW-ACTIVITY WASTE MELTER PROCESS SYTEM DESIGN DESCRIPTION.

DRAWING INDEX	
DWG NO	TITLE
24590-LAW-M6-LMP-00003001	LAW MELTER PROCESS SYSTEM COOLING SYSTEM

REV	DESCRIPTION	ORG	CHKD	RVWD	APVD	DATE
1	REVISED PER NOTE 11	BCR	TM	N/A	AML CMW TRV	6/4/19
0	ISSUED FOR CONSTRUCTION, SEE NOTE 10	MP	APP	SK/SS	RS/JS	8/30/10

REVISION HISTORY

CM
QUALITY DESIGNATOR

ISSUED BY
RPP-WTP PDC
ISSUE STAMP

PROJECT No.	24590
SITE	HANFORD
AREA	200E
BUILDING No.	20

	BY	DATE
ORIGINATOR	PARKER, MICHELLE	8/17/10
CHECKER	PINTO, PAT	8/17/10
APPROVER	STEVENS, R/SCHNEIDER, J	8/30/10
REVIEWER	KRETZSCHMAR, S/SMITH, S	8/25/10

CONTENT APPLICABLE TO ALARA? [X] YES [ ] NO
ADR NO. 24590-LAW-ADR-M-02-026 REV: 4

RIVER PROTECTION PROJECT
WASTE TREATMENT PLANT
2435 STEVENS CENTER PLACE
RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

P&ID - LAW
LAW MELTER PROCESS SYSTEM
MELTER 1
WALLS AND FLOOR PANELS
COOLING SYSTEM

SCALE: NONE
24590-LAW-M6-LMP-00003001
REV 1

'E' SIZE - 44x34
COMPUTER GENERATED - MANUAL DESIGN CHANGES NOT PERMITTED

R11961272

5/30/2019 8:06:46 AM

PLOTTED BY: mthawkin c:\work\mthawkin\dms03838\LAWM6LMP00003001.dgn

FORM E_SDN.DGN 02/2009

Hanford Facility RCRA Permit Modification Notification Forms

Part III, Operating Unit 11
Integrated Disposal Facility

Index

Submitted by Co-Operator:		Reviewed by DOE Program Office:	
Lorna M. Dittmer	July 23, 2020	Duane B. Carter	July 23, 2020
Lorna M. Dittmer	Date	Duane B. Carter	Date

×

Hanford Facility RCRA Permit Modification Form	
Unit: ***Integrated Disposal Facility***	Permit Part ***Part III, Operating Unit Group 11***

Description of Modification:

Unit Specific Conditions

OPERATING UNIT 11:

Chapter 1.0 Part A Form, dated October 1, 2008
Chapter 2.0 Topographic Map Description, dated September 30, 2014
Chapter 3.0 Waste Analysis Plan, dated June 30, 2013
Chapter 4.0 Process Information, dated December 31, 2008
Appendix 4A Design Report (as applicable to critical systems), dated June 30, 2016
Appendix 4B Construction Quality Assurance Plan, dated April 9, 2006
Appendix 4C Response Action Plan, dated April 9, 2006
Appendix 4D Construction Specifications (RPP-18489, Rev. 1), dated December 31, 2006
Appendix C9 Infrastructure Construction Specification (CHPRC-03953, Rev. 0), dated TBD
Chapter 5.0 Ground Water Monitoring, dated June 30, 2010
Chapter 6.0 Procedure to Prevent Hazards, dated June 20, 2013
Addendum J.1 Contingency Plan – Pre-Active Life, dated August 21, 2018
Addendum J.2 Contingency Plan – Active Life, dated March 31, 2016
Chapter 8.0 Personnel Training, dated September 30, 2014
Chapter 11.0 Closure, dated September 30, 2014
Chapter 13.0 Other Federal and State Laws, dated April 9, 2006

Change dates to coincide with Ecology signature approvals and concurrences on the Class [1]1 and 1 modifications herein.

Condition III.11.D.1.d.i, ECN for Critical System – Edited first sentence and added Appendix C9 by replacing "Appendices 4A, 4B, 4C, and 4D" with "Appendices 4A, 4B, 4C, 4D, and C9".

Condition III.11.D.1.d.ii.a – Edited first sentence and added Appendix C9by replacing "Appendices 4A, 4B, 4C, and 4D" with "Appendices 4A, 4B, 4C, 4D, and C9". Also in the first sentence, editorial correction of "a NCR" to "an NCR".

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:	X			

Enter relevant WAC 173-303-830, Appendix I Modification citation number:
A.1 (Administrative and informational changes)

Modification Concurred: ☒ Yes ☐ No	Reviewed by Ecology: Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.08 13:18:16 -07'00' S. N. Schleif — Date

Hanford Facility RCRA Permit Modification Form	
Unit: *Integrated Disposal Facility*	Permit Part *Part III, Operating Unit Group 11*

Description of Modification:

Chapter 4.0, Process Information

Section 4.2 – Added third paragraph to address the new dome covers and new piping for the Leachate Collection Tanks. Also made a few minor editorial changes concerning singular vs., plural wording, deleting the article “the”, and adding the phrase “in each tank”.

Appendix 4A, Section 1, Phase I Critical Systems Design Report

Section 1.1, Purpose – Added paragraph on design information pertaining to modifications to critical systems performed during IDF infrastructure construction and referenced CHPRC-03958, *Final Design Report for the Integrated Disposal Facility Infrastructure.*

Section 1.2.2, Design Report – Updated 7th bullet to include the phrase “leachate transfer pipe lines”.

Section 1.4, General Facility Description –Edited wording in the 8th bullet correcting the term “landfill half” to “landfill cell”. Corrected two minor typos - “leachate collection tank” to “leachate collection tanks” and “side” to “site”.

Section 5.9.1.2, Leachate System Loading Analyses for Piping Outside of Phase I Liner Limits – Added engineering drawing sheet number references to “Drawing H-2-830846, Sheets 1-2”. Added to the second to last sentence the phrase “for Phase I”. Added new last sentence: “The loading calculation for the added pipeline between transfer buildings is available in CHPRC-03955, *Leachate Pipe Loading Calculation*.”

Section 5.9.2.3, Leachate System Pumps and Force Mains Analyses – Added phrase “for Phase I” to second sentence: “Calculations for Phase I are included in Appendix C.8.b.” Added new last sentence referencing CHPRC-03956, *Leachate Hydraulic Calculation.*

Section 5.10, Surface Stormwater – Edited second to last sentence adding the phrase, “…and the leachate tank covers” and deleted two phrases “caught in the gutters” and “via downspouts”. Deleted last sentence concerning stormwater evaporating off the floating covers since domes are replacing the floating covers.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class [1]1 modification pursuant to WAC 173-303-830(4)(d).

Modification Approved: X Yes ☐ No	Reviewed by Ecology:
	Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.08 13:18:42 -07'00'
	S. N. Schleif — Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Integrated Disposal Facility	***Part III, Operating Unit Group 11***

Description of Modification:

Appendix 4A, Section 1, Phase I Critical Systems Design Report (continued)

Added new Section 5.12.2.5 - Leachate Tank Dome Cover Structural Analysis

Added new Section 5.12.2.6 - Leachate Transfer Pipeline Loading Calculation

Section 6.4.2.1 Description – Added wording that the leachate transfer piping allows pumping of leachate from each landfill cell to either leachate collection tank. Deleted the parenthetical "(see Section 6.4.2.2)". Made minor editorial changes for singular to plural words, i.e., "crest pad buildings", "leachate transfer buildings", "storage tanks" and "tanker truck load facilities". Added two last paragraphs describing in more detail, the leachate transfer pipeline.

Section 6.4.4.2, Tank Design – Removed reference to the "floating geomembrane" cover. Also replaced "open topped" with "covered".

Added new Section 6.4.4.5 - Fabricated Dome Cover

Section 6.4.5.3, Leachate Storage Tank – Removed reference to the floating cover. Also added new paragraph discussing tank level instrumentation and access to stilling wells and instrument interfaces.

Section 7.2.3, IDF Leachate Handling System –Deleted the 4th bullet concerning the floating covers.

Section 7.3.1, Action Leakage Rate – Updated first sentence of second paragraph by adding phrase "over a seven-day period" to clarify Action Leakage Rate calculation.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class [1]1 modification pursuant to WAC 173-303-830(4)(d)..

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:

Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.08 13:19:10 -07'00'

S. N. Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Integrated Disposal Facility	***Part III, Operating Unit Group 11***

Description of Modification:

Appendix 4A, Section 3, Critical Systems Design Drawings

Table of Contents – New/updated drawings have been added to 4A3. Update the TOC accordingly.

After “Drawing 1, H-2-830828, Sheet 1”, add new “Drawing 2, H-2-830829, Sheet 2, Rev 1.”

Update title “Drawing 2, H-2-830832” to “Drawing 3, H-2-830832”
Update title “Drawing 3, H-2-830836” to “Drawing 4, H-2-830836”
Update title “Drawing 4, H-2-830837” to “Drawing 5, H-2-830837”
Update title “Drawing 5, H-2-830838” to “Drawing 6, H-2-830838”
Update title “Drawing 6, H-2-830839” to “Drawing 7, H-2-830839”
Update title “Drawing 7, H-2-830840” to “Drawing 8, H-2-830840”

Replace “Drawing 8, H-2-830845”, Rev 0, with updated “Drawing 9, H-2-830845, Rev 1”.

Replace “Drawing 9, H-2-830846”, Rev 0, with updated “Drawing 10, H-2-830846, Sheet 1, Rev 1”.

After new “Drawing 10, H-2-830846, Sheet 1, Rev 1”, add new “Drawing 11, H-2-830846, Sheet 2, Rev 0”.

Update title “Drawing 10, H-2-830848” to “Drawing 12, H-2-830848”
Update title “Drawing 11, H-2-830850” to “Drawing 13, H-2-830850, Sheet 1”

After updated “Drawing 13, H-2-830850”, add new drawings:
Drawing 14, H-2-830850, Sheet 2, Rev 0
Drawing 15, H-2-830851, Sheet 1, Rev 1
Drawing 16, H-2-830852, Sheet 1, Rev 1.

Update title “Drawing 12, H-2-830854, Sheet 1”, Rev 0, to “Drawing 17, H-2-830854, Sheet 1, Rev 0”.

WAC 173-303-830 Modification Class	Class 1	Class '1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class 1-prime modification pursuant to WAC 173-303-830(4)(d).

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:

Schleif, Stephanie (ECY)

Digitally signed by Schleif, Stephanie (ECY)
Date: 2020.09.08 13:19:36 -07'00'

S. N. Schleif   Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Integrated Disposal Facility	***Part III, Operating Unit Group 11***

Description of Modification:

Appendix 4A, Section 3, Critical Systems Design Drawings – continued

Replace old “Drawing 13, H-2-830854, Sheet 2” with updated “Drawing 18, H-2-830854, Sheet 2, Rev 1”

After updated “Drawing 18, H-2-830854, Sheet 2”, Rev 1, add new drawings:
Drawing 19, H-2-830854, Sheet 4, Rev 1
Drawing 20, H-2-830858, Sheet 1, Rev 1.

Replace “Drawing 14, H-2-830869” with updated “Drawing 21, H-2-830869, Rev 1”.

After updated “Drawing 21, H-2-830869” , add new drawings:
Drawing 22, H-2-830872, Sheet 1, Rev 1
Drawing 23, H-2-837964, Sheet 5
Drawing 24, H-2-837964, Sheet 6
Drawing 25, H-2-837972, Sheet 1
Drawing 26, H-2-837972, Sheet 2
Drawing 27, H-2-837972, Sheet 3
Drawing 28, H-2-837973, Sheet 1
Drawing 29, H-2-837973, Sheet 2
Drawing 30, H-2-837973, Sheet 3.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class [1]1 modification pursuant to WAC 173-303-830(4)(d).

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:

Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.08 13:20:13 -07'00'

S. N. Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Integrated Disposal Facility	***Part III, Operating Unit Group 11***

Description of Modification:

Appendix 4D, Construction Specifications

At the end of Section 09900 on page 4D.153, in the "Notes" area, delete note #6. Change former note #7 to new note #6. [Note that as new information is added to the documents, the page numbers may shift so update accordingly.]

On page 4D.196, delete "Floating Cover" from the title, "Tank Secondary and Primary Liners and Floating Cover" to read as "Tank Secondary and Primary Liners".

On page 4D.196, under the paragraph entitled, "Tank and Equipment", delete the word "floating" and the phrase "floating cover water removal system".

On page 4D.199, under the paragraph entitled, "Warranty", delete the word "floating".

On page 4D.201, under the paragraph entitled, "Tank Components", delete the word "floating".

On page 4D.202, delete "Floating Cover" from the title, "Tank Secondary and Primary Liners and Floating Cover" to read as "Tank Secondary and Primary Liners". Delete "and floating covers" from 1st sentence.

On page 4D.203, under the paragraph entitled, "EXPANSION/CONTRACTION", delete the entire subparagraph entitled, "Floating Cover".

On page 4D.204, delete the entire subparagraph entitled, "Tank Ladder".

WAC 173-303-830 Modification Class	Class 1	Class ^{1}1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class ^{1}1 modification pursuant to WAC 173-303-830(4)(d).

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:

Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.09.08 13:20:39 -07'00'

S. N. Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Integrated Disposal Facility	***Part III, Operating Unit Group 11***

Description of Modification:

Appendix 4D, Construction Specifications (continued)

On page 4D.205, under the paragraph entitled, "Tank Installation", delete the word "floating".

On page 4D.206, delete the entire subparagraph entitled, "Floating Cover Drainage Test".

On page 4D.286, at paragraph 4.a., delete the word "floating".

Appendix C9, Infrastructure Construction Specification (CHPRC-039953, Rev. 0)

Add new appendix.

WAC 173-303-830 Modification Class	Class 1	Class ¹1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Some of the changes described above correspond with WAC 173-303-830 Appendix I, A.1 (Administrative and informational changes) and A.2 (Correction of typographical errors).

Upgrading tank component from a floating roof to a dome and upgrades to piping to allow Operations to transfer leachate between tanks are not explicitly listed in WAC 173-303-830, Appendix I. The permittees request that the proposed change be reviewed and approved as a Class ¹1 modification pursuant to WAC 173-303-830(4)(d).

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:
Schleif,
Stephanie (ECY)
Digitally signed by Schleif, Stephanie (ECY)
Date: 2020.09.08 13:21:11 -07'00'

S. N. Schleif Date

Revision Instructions:

Revise Unit Specific Conditions, Chapter 4.0, Appendix 4A, Section 1, Appendix 4A, Section 3, Appendix 4D and Appendix C9 to incorporate the changes shown herein.

INTEGRATED DISPOSAL FACILITY
CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have a "**Last Modification Date**" which represents the last date the portion of the unit has been modified. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Last modification to Integrated Disposal Facility **June 11, 2020**

Chapters	Last Modification Date	Modification Number
Unit-Specific Permit Conditions	06/11/2020	PCN-IDF-2020-03 (8C.2020.Q2)
1.0 Part A Form	10/01/2008	
2.0 Topographic Map Description	09/30/2014	
3.0 Waste Analysis Plan	06/30/2013	
4.0 Process Information	12/31/2008	
4A1 Phase I Critical Systems Design Report	08/25/2016	8C.2016.Q2
4A2 Critical Systems Tables & Data Sheets	03/31/2008	
4A3 Critical Systems Design Drawings	03/31/2008	
4B Detailed Design Cell 1 Construction Quality Assurance Plan	04/09/2006	
4C Facility Response Action Plan	04/09/2006	
4D Construction Specifications (C-1)	12/31/2006	
C9 Infrastructure Construction Specification		
5.0 Groundwater Monitoring	06/30/2010	
6.0 Procedures to Prevent Hazards	06/20/2013	
7.0 Reserved		
8.0 Personnel Training	09/30/2014	
9.0 Reserved		
10.0 Reserved		
11.0 Closure	09/30/2014	
12.0 Reserved		
13.0 Other Federal and State Laws	04/09/2006	
Addenda	**Last Modification Date**	**Modification Number**
Addendum J.1 Pre-Active Life Contingency Plan	06/11/2020	PCN-IDF-2020-03 (8C.2020.Q2)
Addendum J.2 Active Life Contingency Plan	05/23/2016	8C.2016.Q1

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INTEGRATED DISPOSAL FACILITY
PART III, OPERATING UNIT GROUP 11
UNIT-SPECIFIC PERMIT CONDITIONS

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
06/11/2020	PCN-IDF-2020-03 (8C.2020.Q2)
08/21/2018	PCN-IDF-2018-01 (8C.2018.Q3)
08/25/2016	8C.2016.Q2

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INTEGRATED DISPOSAL FACILITY
PART III, OPERATING UNIT GROUP 11
UNIT-SPECIFIC PERMIT CONDITIONS

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PART III, OPERATING UNIT GROUP 11 UNIT-SPECIFIC PERMIT CONDITIONS INTEGRATED DISPOSAL FACILITY

This document sets forth the operating conditions for the Integrated Disposal Facility (IDF).

III.11.A COMPLIANCE WITH APPROVED PERMIT

The Permittees shall comply with all requirements set forth in the Integrated Disposal Facility (IDF) Permit Conditions, the Chapters and Appendices specified in Permit Condition III.11.A and the Amendments specified in Permit Conditions III.11.B through III.11.I. All subsections, figures, and tables included in these portions are enforceable unless stated otherwise:

OPERATING UNIT 11:

Chapter 1.0	Part A Form, dated October 1, 2008
Chapter 2.0	Topographic Map Description, dated September 30, 2014
Chapter 3.0	Waste Analysis Plan, dated June 30, 2013
Chapter 4.0	Process Information, dated ~~December 31, 2008~~TBD
Appendix 4A	Design Report (as applicable to critical systems), dated ~~June 30, 2016~~TBD
Appendix 4B	Construction Quality Assurance Plan, dated April 9, 2006
Appendix 4C	Response Action Plan, dated April 9, 2006
Appendix 4D	Construction Specifications (RPP-18489, Rev. 1), dated ~~December 31, 2006~~TBD
Appendix C9	Infrastructure Construction Specification (CHPRC-03953, Rev. 0), dated TBD
Chapter 5.0	Ground Water Monitoring, dated June 30, 2010
Chapter 6.0	Procedure to Prevent Hazards, dated June 20, 2013
Addendum J.1	Contingency Plan – Pre-Active Life, dated June 11, 2020
Addendum J.2	Contingency Plan – Active Life, dated March 31, 2016
Chapter 8.0	Personnel Training, dated September 30, 2014
Chapter 11.0	Closure, dated September 30, 2014
Chapter 13.0	Other Federal and State Laws, dated April 9, 2006

General and Standard Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, WA7890008967 (Permit) conditions (Part I and Part II Conditions) applicable to the IDF are identified in Permit Attachment 9, *Permit Applicability Matrix*.

III.11.B AMENDMENTS TO THE APPROVED PERMIT

III.11.B.1 Portions of Permit Attachment 4, *Hanford Emergency Management Plan* that are not made enforceable by inclusion in the applicability matrix for that document, are not made enforceable by reference in this document.

III.11.B.2 Permittees must comply with all applicable portions of the Permit. The facility and unit-specific recordkeeping requirements are distinguished in the General Information Portion of the Permit, and are tied to the Permit conditions.

III.11.B.3 The scope of this Permit is restricted to the landfill construction and operation as necessary to dispose of: (1) Immobilized Low-Activity Waste (ILAW) from the Waste Treatment Plant (WTP), and (2) the Demonstration Bulk Vitrification System (DBVS) and IDF operational waste as identified in Chapter 4.0. Future expansion of the RCRA trench, or disposal of other wastes not specified in this Permit, is prohibited unless authorized via modification of this Permit.

III.11.B.4 In accordance with Washington Administrative Code (WAC) 173-303-806(11)(d), this Permit shall be reviewed every five (5) years after the effective date and modified, as necessary, in accordance with WAC 173-303-830(3).

III.11.B.5 Inspection Requirements – Pre-Active Life Period and Active Life Period

III.11.B.5.a The Permittees will conduct inspections of the IDF according to the following requirements:

III.11.B.5.a.i Prior to the start of the active life of the IDF as defined in WAC 173-303-040, according to Chapter 6.0, Table 6.2.

III.11.B.5.a.ii Following the start of the active life of the IDF as defined in WAC 173-303-040, according to Chapter 6.0, Table 6.2A.

III.11.B.5.b The Permittees will remedy any problems revealed by inspections conducted pursuant to Permit Condition III.11.B.5.a on a schedule, which prevents hazards to the public health and the environment and as agreed to in writing, by the Department of Ecology (Ecology). Where a hazard is imminent or has already occurred, remedial action must be taken immediately.

III.11.B.5.c Reserved

III.11.B.5.d Rainwater Management

III.11.B.5.e Prior to the start of the active life of the IDF, the Permittees will manage the discharge of such water in accordance with the pollution prevention and best management practices required by State Waste Discharge Permit Number ST 4511.

III.11.B.5.e.i Management of Liquids Collected in the Leachate Collection and Removal System (LCRS), Leak Detection System (LDS), and Secondary Leak Detection System (SLDS) prior to the start of the active life of the IDF.

III.11.B.5.e.ii Permittees shall manage the liquid in the LCRS in a manner that does not allow the fluid head to exceed 30.5 cm above the flat 50-foot by 50-foot LCRS sump High Density Polyethylene (HDPE) bottom liner, and the LCRS sump trough, except for storms that exceed the 25-year, 24-hour storm event [WAC 173-303-665(2)(h)(ii)]. Liquid with a depth greater than 30.5 cm above the LCRS liner will be removed at the earliest practicable time after detection (not to exceed 5 working days).

III.11.B.5.e.iii Accumulated liquid of pumpable quantities in the LDS and SLDS will be managed in a manner that does not allow the fluid head to exceed 30.5 cm above the LDS liner or SLDS liner [WAC 173-303-665(2)(h)(ii) and (iii)]. Liquid with a depth greater than 30.5 cm above a liner will be removed at the earliest practicable time after detection (not to exceed 5 working days).

III.11.B.5.e.iv The Permittees will use a flow meter to check if the amount of actual liquid pumped corresponds to the amount accumulated in the leachate collection tank to verify the proper function of the leachate collection and removal sump pumps with each use. The Permittees will document in the IDF portion of the facility operating record appropriate quality assurance/quality control requirements for selection and operation of the flow meter based on the required verification. In addition, the Permittees will evaluate the leachate transfer lines for freeze and thaw damage when ambient conditions may cause such damage to occur. The Permittees will document the methods and criteria used for purposes of this evaluation, along with an appropriate justification.

III.11.B.5.e.v The Permittee will inspect for liquids after significant rainfall events.

III.11.B.5.e.vi The Permittee will annually verify monitoring gauges and instruments are in current calibration; calibration will be performed annually or more frequently at intervals suggested by the manufacturer (refer to Chapter 4.0, §4.3.7.4).

III.11.B.5.f The Permittees will monitor liquids in the LCRS and LDS to ensure the action leakage rate (Chapter 4.0, Appendix 4A) is not exceeded.

III.11.B.5.g Soil Stabilization

Prior to the first placement of waste in the IDF, the Permittee will apply soil stabilization materials as needed to prevent soil erosion in and around the landfill.

III.11.C Design Requirements

III.11.C.1 IDF is designed in accordance with WAC 173-303-665 and WAC 173-303-640 as described in Chapter 4.0. Design changes impacting IDF critical systems shall be performed in accordance with Permit Conditions III.11.D.1.d.i and III.11.D.1.d.ii.

III.11.C.1.a IDF Critical Systems include the following: the LCRS, Leachate Collection Tank (LCT), LDS, Liner System (LS), and closure cap. H-2 Drawings for the LCRS, LCT, LDS, and LS are identified in Appendix 4A, Section 3 of this Permit. Drawings for the closure cap will be provided pursuant to Permit Condition III.11.C.1.c.

The Permittees shall construct and operate the IDF in accordance with all specifications contained in RPP-18489, Rev 0. Critical systems, as defined in the definitions section of the Site-wide RCRA Permit, are identified in Appendix 4A, Section 1 of this Permit.

III.11.C.1.b Landfill Cap

At final closure of the landfill, the Permittees shall cover the landfill with a final cover (closure cap) designed and constructed [WAC 173-303-665(6), WAC 173-303-806(4)(h)] to: provide long-term minimization of migration of liquids through the closed landfill; function with minimum maintenance; promote drainage and minimize erosion or abrasion of the cover; accommodate settling and subsidence so that the cover's integrity is maintained; and have a permeability less than or equal to the permeability of any bottom liner system or natural sub soils present.

III.11.C.1.c Compliance Schedule

Proposed conceptualized final cover design is presented in Chapter 11, Closure Requirements. Six months prior to start of construction of IDF landfill final cover (but no later than 6 months prior to acceptance of the last shipment of waste at the IDF), the Permittees shall submit IDF landfill final cover design, specifications and Construction Quality Assurance (CQA) Plan to Ecology for review and approval. No construction of the final cover may proceed until Ecology approval of the final design is given, through a permit modification.

III.11.C.1.d The Permittees shall notify Ecology at least sixty (60) calendar days prior to the date it expects to begin closure of the IDF landfill in accordance with WAC 173-303-610(c).

III.11.C.2 Design Reports

III.11.C.2.a New Tank Design Assessment Report

Permittees shall generate a written report in accordance with WAC 173-303-640(3)(a), providing the results of the leachate collection tank system design assessment. The report shall be reviewed and certified by an Independent Qualified Registered Professional Engineer (IQRPE)[1] in accordance with WAC-173-303-810(13)(a).

III.11.C.2.b Compliance Schedule

Permittees shall submit the leachate collection tank design assessment report to Ecology along with the IQRPE certification, prior to construction of any part of the tank system including ancillary equipment.

III.11.D CONSTRUCTION REQUIREMENTS

III.11.D.1 Construction Quality Assurance

III.11.D.1.a Ecology shall provide field oversight during construction of critical systems. In cases where an Engineering Change Notice (ECN) and/or Non-Conformance Report (NCR) are required, Ecology and the Permittees shall follow steps for processing changes to the approved design per Permit Conditions III.11.D.1.d.i and III.11.D.1.d.ii.

III.11.D.1.b Permittees shall implement the CQA plan (Appendix 4B of the Permit) during construction of IDF.

III.11.D.1.b.i The Permittees will not receive waste in the IDF until the owner or operator has submitted to Ecology by certified mail or hand delivery a certification signed by the CQA officer that the approved CQA plan has been successfully carried out and that the unit meets the requirements of WAC 173-303-665(2)(h) or (j); and the procedure in WAC 173-303-810(14)(a) has been completed. Documentation supporting the CQA officer's certification shall be furnished to Ecology upon request.

III.11.D.1.c Construction Inspection Reports

Permittees shall submit a report documenting the results of the leachate tank installation inspection. This report must be prepared by an Independent, Qualified Installation Inspector or a professional IQRPE either of whom is trained and experienced in the proper installation of tank systems or components. The Permittees will remedy all discrepancies before the tank system is placed in use. This report shall be submitted to Ecology 90 days prior to IDF operation and be included in the IDF Operating Record. [WAC 173-303-640(3)(h)].

III.11.D.1.d ECN/NCR Process for Critical Systems

Portions of the following conditions for processing engineering change notices and non-conformance reporting were extracted from and supersede Site-wide General Permit Condition II.L.

[1] "Independent Qualified Registered Professional Engineer," as used here and elsewhere with respect to Operating Unit Group 11, means a person who is licensed by the state of Washington, or a state which has reciprocity with the state of Washington as defined in Revised Code of Washington (RCW) 18.43.100, and who is not an employee of the owner or operator of the facility for which construction or modification certification is required. A Qualified Professional Engineer is an engineer with expertise in the specific area for which a certification is given.

III.11.D.1.d.i ECN for Critical Systems

During construction of the IDF, the Permittees shall formally document changes to the approved designs, plans, and specifications, identified in Appendices 4A, 4B, 4C, ~~and~~ 4D, and C9 of this Permit, with an ECN.

The Permittees shall maintain all ECNs in the IDF unit-specific Operating Record and shall make them available to Ecology upon request or during the course of an inspection. The Permittees shall provide to Ecology copies of proposed ECNs affecting any critical system within five (5) working days of initiating the ECN. Identification of critical systems is included in Permit Condition III.11.C.1 and Appendix 4A of this Permit. Within five (5) working days, Ecology will review a proposed ECN modifying a critical system and inform the Permittees whether the proposed ECN, when issued, will require a Class 1, 2, or 3 Permit modification.

III.11.D.1.d.ii Non-Conformance Reporting for Critical Systems

III.11.D.1.d.ii.a During construction of the IDF, the Permittees shall formally document with an NCR, any work completed which does not meet or exceed the standards of the approved design, plans and specifications, identified in Appendices 4A, 4B, 4C ~~and~~ 4D, and C9 of this Permit. The Permittees shall maintain all NCRs in the IDF unit-specific Operating Record and shall make them available to Ecology upon request, or during the course of an inspection.

III.11.D.1.d.ii.b The Permittees shall provide copies of NCRs affecting any critical or regulated system to Ecology within five (5) working days after identification of the non-conformance. Identification of critical systems is included in Permit Condition III.11.C.1 and Appendix 4A of this Permit. Ecology will review a NCR affecting a critical system and notify the Permittees within five (5) working days, in writing, whether a Permit modification is required for any nonconformance, and whether prior approval is required from Ecology before work proceeds, which affects the nonconforming item.

III.11.D.1.d.ii.c As-Built Drawings

Upon completing construction of IDF, the Permittees shall produce as-built drawings of the project, which incorporate the design and construction modifications resulting from all project ECNs and NCRs, as well as modifications made pursuant to WAC 173-303-830. The Permittees shall place the drawings into the Operating Record within twelve (12) months of completing construction.

III.11.D.2 The Permittees shall not reduce the minimum frequency of destructive testing less than one test per 500 feet of seam, without prior approval in writing from Ecology.

III.11.E GROUNDWATER AND GROUNDWATER MONITORING

Groundwater shall be monitored in accordance with + and the provisions contained in the Ecology-approved facility "Groundwater Monitoring" (Chapter 5.0). All wells used to monitor the groundwater beneath the unit shall be constructed in accordance with the provisions of WAC 173-160.

III.11.E.1 Groundwater Monitoring Program

III.11.E.1.a Prior to initial waste placement in the IDF landfill, the Permittees shall sample all groundwater monitoring wells in the IDF network twice quarterly for one first year to determine baseline conditions. For the first sampling event (and only the first), samples for each well will include all constituents in 40 Code of Federal Regulations (CFR) 264 Appendix IX. Thereafter, sampling will include only those constituents as specified in Chapter 5.0, Table 5-2: chromium (filtered and unfiltered the first year to compare results), specific conductance, Total Organic Carbons, Total Organic Halide, and pH. Other constituents to be monitored but not statistically compared include alkalinity, anions, Inductively Coupled Plasma metals, and turbidity. These will provide important information on hydrogeologic characteristics of the aquifer and may provide indications of encroaching contaminants from other facilities not associated with IDF.

III.11.E.1.b After the baseline monitoring is completed, and data is analyzed, the Permittees and Ecology shall assess revisions to Chapter 5.0, Table 5-2. Subsequent samples will be collected annually and will include constituents listed in Table 5-2 as approved by Ecology. All data analysis will employ Ecology approved statistical methods pursuant to WAC 173-303-645. Changes to Chapter 5.0 will be subject to the permit modification procedures under WAC 173-303-830.

III.11.E.1.c All constituents used as tracers to assess performance of the facility through computer modeling should be sampled at least annually to validate modeling results. Groundwater monitoring data and analytes to be monitored will be reviewed periodically as defined in Chapter 5.0 of this Permit.

III.11.E.1.d Upon Ecology approval of the leachate monitoring plan, leachate monitoring and groundwater monitoring activities should be coordinated as approved by Ecology to form an effective and efficient means of monitoring the performance of the IDF facility.

III.11.E.1.e Groundwater monitoring data shall be reported to Ecology annually by July 31. The annual report shall include monitoring results for the 12-month period from January 1 through December 31.

III.11.F LEACHATE COLLECTION COMPONENT MANAGEMENT

Permittees shall design, construct, and operate all leachate collection systems to minimize clogging during the active life and post closure period.

III.11.F.1 Leachate Collection and Removal System

III.11.F.1.a At least 120 days prior to initial waste placement in the IDF, the Permittees shall submit a Leachate monitoring plan to Ecology for review, approval, and incorporation into the permit. Upon approval by Ecology, this plan will be incorporated into the Permit as a class [1]1 modification. The Permittees shall not accept waste into the IDF until the requirements of the leachate monitoring plan have been incorporated into this Permit.

III.11.F.1.b Leachate in the LCRS (primary sump) shall be sampled and analyzed monthly for the first year of operation of the facility and quarterly thereafter (pursuant to WAC 173-303-200). Additionally, leachate shall be sampled and analyzed to meet waste acceptance criteria at the receiving Treatment Storage and Disposal Facility.

III.11.F.1.c Permittees shall manage the leachate in the LCRS in a manner that does not allow the fluid head to exceed 30.5 cm above the flat 50-foot by 50-foot LCRS sump HDPE bottom liner except for rare storm events as discussed in Chapter 4.0, §4.3.6.1 and the LCRS sump trough [WAC 173-303-665(2)(h)(ii)]. Liquid with a depth greater than 30.5 cm above the SLDS liner will be removed at the earliest practicable time after detection (not to exceed 5 working days).

III.11.F.1.d After initial waste placement, Permittees shall manage all leachate from the permitted cell as dangerous waste (designated with Dangerous Waste Number F039) in accordance with WAC 173-303.

III.11.F.2 Monitoring and Management of LDS (LDS/secondary sump)

III.11.F.2.a Permittees shall manage the leachate in the LDS in a manner that does not allow the fluid head to exceed 30.5 cm above the LDS liner [WAC 173-303-665(2)(h)(ii)].

III.11.F.2.b Permittees shall monitor and record leachate removal for comparison to the Action Leakage Rate (ALR) as described in Appendix 4C, Response Action Plan. If the leachate flow rate in the LDS exceeds the ALR, the Permittees shall implement the Ecology approved Response Action Plan (Appendix 4C).

III.11.F.2.c Leachate from the LDS (secondary sump) shall be sampled semi-annually if a pumpable quantity of leachate is available for sampling.

III.11.F.2.d Accumulated liquid of pumpable quantities in the LDS will be managed in a manner that does not allow the fluid head to exceed 30.5 cm above the LDS liner [WAC 173-303-665(2)(h)(ii) and (iii)]. Liquid with a depth greater than 30.5 cm above the LDS liner will be removed at the earliest practicable time after detection (not to exceed 5 working days).

III.11.F.3 Monitoring and Management of the SLDS

III.11.F.3.a At least 180 days prior to initial waste placement, the, the Permittees shall submit to Ecology for approval a Sub-Surface Liquids Monitoring and Operations Plan (SLMOP) for the SLDS to include the following: monitoring frequency, pressure transducer configuration, liquid collection and storage processes, sampling and analysis and response actions. The SLMOP shall be approved by Ecology prior to placement of waste in the IDF, and incorporated into the Permit as a Class [1]1 modification.

III.11.F.3.b Permittees shall monitor and manage the SLDS (tertiary sump) pursuant to the approved sub-surface liquids monitoring and operations plan.

III.11.F.3.c Accumulated liquid of pumpable quantities in the SLDS will be managed in a manner that does not allow the fluid head to exceed 30.5 cm above the SLDS liner [WAC 173-303-665(2)(h)(ii) and (iii)]. Liquid with a depth greater than 30.5 cm above the SLDS liner will be removed at the earliest practicable time after detection (not to exceed 5 working days).

III.11.F.3.d After initial waste placement, Permittees shall manage all leachate from the permitted cell as dangerous waste in accordance with WAC 173-303.

III.11.G CONSTRUCTION WATER MANAGEMENT

III.11.G.1 During construction, it is anticipated that liquids will accumulate on top of all liners and sumps. Permittees shall manage the construction wastewater in accordance with State Waste Discharge Permit ST 4511.

III.11.G.2 Liquid accumulation within the LCRS, LDS, and SLDS prior to initial waste placement will be considered construction wastewater (i.e., not leachate).

III.11.H LANDFILL LINER INTEGRITY MANAGEMENT & LANDFILL OPERATIONS

III.11.H.1 Permittees shall design, construct, and operate the landfill in a manner to protect the liners from becoming damaged. Temperature: waste packages with elevated temperatures shall be evaluated and managed in a manner to maintain the primary (upper) liner below the design basis temperature for the liner (e.g.,160 F). Weight: waste, fill material and closure cover shall be placed in a manner that does not exceed the allowable load bearing capacity of the liner (weight per area 13,000 lb/ft^2). Puncture: at least 3 feet of clean backfill material shall be placed as an operations layer over the leachate collection and removal system to protect the system from puncture damage.

III.11.H.1.a All equipment used for construction and operations inside of the IDF shall meet the weight limitation as specified in Permit Condition III.11.H.1. Only equipment that can be adequately supported by the operations layer as specified in Permit Condition III.11.H.1 (e.g., will not have the potential to puncture the liner) shall be used inside of the IDF. All equipment used for construction and operations outside of the IDF shall not damage the berms. Changes to any equipment will follow the process established by Condition II.R of the Site-wide permit. Within 120 days from the effective date for the permit, a process for demonstrating compliance with this condition shall be submitted for review by Ecology. This process will be incorporated into appropriate IDF operating procedures prior to IDF operations.

III.11.H.2 The Permittees shall construct berms and ditches to prevent run-on and run-off in accordance with the requirements of Chapter 4, Section 4.3.8 of the IDF portion of this Permit. Before the first placement of waste in the IDF, the Permittees shall submit to Ecology a final grading and topographical map on a scale sufficient to identify berms and ditches used to control run-on and run-off. Upon approval, Ecology will incorporate these maps into the permit as a Class [1]1 modification.

III.11.H.3 The Permittees shall operate the RCRA IDF Cell (Cell 1) in accordance with WAC 173-303-665(2) and the operating practices described in Chapters 3.0, 4.0, 6.0, 8.0, Addendum J.1, Addendum J.2, and Appendix 4A, §1, subsection 7, except as otherwise specified in this Permit.

III.11.H.4 The Permittees shall maintain a permanent and accurate record of the three-dimensional location of each waste type, based on grid coordinates, within the RCRA IDF Cell (Cell 1) in accordance with WAC 173-303-665(5).

III.11.I WASTE ACCEPTANCE CRITERIA

The only acceptable waste form approved for disposal at the RCRA cell of IDF are IDF operational waste, ILAW in glass form from the WTP Low-Activity Waste (LAW) Vitrification Facility and ILAW from the Bulk Vitrification Research Demonstration and Development Facility (up to 50 boxes). Specifics about waste acceptance criteria for each of these wastes are detailed below.

No other waste forms may be disposed at the RCRA cell of IDF unless authorized via a Final Permit modification decision. Requests for Permit modifications must be accompanied by an analysis adequate for Ecology to comply with State Environmental Policy Act (SEPA), as well as by a risk assessment and groundwater modeling to show the environmental impact. Permit Condition III.11.I.5 outlines the process by which waste sources in the IDF are modeled in an ongoing risk budget and a groundwater impact analysis.

III.11.I.1 Six months prior to IDF operations Permittees shall submit to Ecology for review, approval, and incorporation into the permit, all waste acceptance criteria to address, at a minimum, the following: physical/chemical criteria, liquids and liquid containing waste, land disposal restriction treatment standards and prohibitions, compatibility of waste with liner, gas generation, packaging, handling of packages, minimization of subsidence.

III.11.I.1.a All containers/packages shall meet void space requirements pursuant to WAC 173-303-665(12).

III.11.I.1.b Compliance Schedule

III.11.I.1.b.i Six months prior to IDF operations, the Permittees shall submit to Ecology for review, approval, and incorporation into the Permit any necessary modifications to the IDF "Waste Analysis Plan" (Chapters 3.0 of the IDF portion of this Permit).

III.11.I.2 ILAW Waste Acceptance Criteria

The only ILAW forms acceptable for disposal at IDF are: (1) approved glass canisters that are produced in accordance with the terms, conditions, and requirements of the WTP portion of the Permit, and (2) the 50 bulk vitrification test boxes as specified in the DBVS test plans.

To assure protection of human health and the environment, it is necessary that the appropriate quality of glass be disposed at IDF. The Land Disposal Restrictions (LDR) Treatment Standard for eight metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), when associated with High-Level Waste, is High Level VIT (HLVIT) (40 CFR 268). Because these metals are constituents in the Hanford Tanks Waste, the LDR standard for ILAW disposed to IDF is HLVIT.

For any ILAW glass form(s) that the United States Department of Energy (DOE) intends to dispose of in IDF, DOE will provide to Ecology for review, an ILAW Waste Form Technical Requirements Document (IWTRD). The IWTRD will contain:

III.11.I.2.a WTP ILAW Waste Acceptance Criteria

III.11.I.2.a.i A description of each specific glass formulation that DOE intends to use including a basis for why each specific formulation is proposed for use, which specific tank wastes the glass formulation is proposed for use with, the characteristics of the glass that are key to satisfactory performance (e.g., Vapor Hydration Test [VHT], Product Consistency Test [PCT], and Toxicity Characteristic Leaching Procedure [TCLP] and/or other approved performance testing methodologies that the parties agree are appropriate and necessary), the range in key characteristics anticipated if the specific glass formulation is produced on a production basis with tank waste, and the factors that DOE must protect against in producing the glass to ensure the intended glass characteristics will exist in the actual ILAW.

III.11.I.2.a.ii A performance assessment that provides a reasonable basis for assurance that each glass formulation will, once disposed of in IDF in combination with the other waste volumes and waste forms planned for disposal at the entire IDF, be adequately protective of human health and the environment; and will not violate or be projected to violate all applicable state and federal laws, regulations and environmental standards.

Within 60 days of a request by Ecology, the Permittees shall provide a separate model run using Ecology's assumptions and model input.

III.11.I.2.a.iii A description of production processes including management controls and quality assurance/quality control requirements that assure that glass produced for each formulation will perform in a reasonably similar manner to the waste form assumed in the performance assessment for that formulation.

The Permittees shall update the IWTRD consistent with the above requirements for review by Ecology consistent with their respective roles and authority as provided under the Tri-Party Agreement (TPA). Ecology comments shall be dispositioned through the Review Comment Record (RCR) process and will be reflected in further modeling to modify the IDF ILAW Chapter 3.0, "Waste Analysis Plan" as appropriate.

The initial IWTRD contained glass formulation data as required by Permit Condition III.11.I.2.a.i, and was submitted on December 18, 2006 (AR Accession # 0906020182). The performance assessment required by Permit Condition III.11.I.2.a.ii, and the quality assurance/quality control requirements process required by Permit Condition III.11.I.2.a.iii shall be submitted for Ecology review as soon as possible after issuance of the Final Tank Closure and Waste Management Environment Impact Statement (EIS) and receipt of underlying codes and data packages, and at least 180 days prior to the date DOE expects to receive waste at IDF. At a minimum, the Permittees shall submit updates to the IWTRD to Ecology every five years or more frequently with the next one due June 30, 2015, if any of the following conditions exist:

- The Permittees submits a permit modification request allowing additional waste forms to be disposed of at IDF.
- The WTP or other vitrification facility change their glass formulations from those previously included in the IWTRD.
- An unanticipated event or condition occurs that Ecology determines would warrant an update to the IWTRD.

III.11.I.2.a.iv The Permittees shall not dispose of any WTP ILAW not described and evaluated in the IWTRD.

III.11.I.3 ILAW Waste Acceptance Criteria Verification.

III.11.I.3.a Six months prior to disposing of ILAW in the IDF, the Permittees will submit an ILAW verification plan to Ecology for review and approval. This plan will be coordinated with WTP, Ecology, and the Permittees personnel. This plan will outline the specifics of verifying ILAW waste acceptance through WTP operating parameters, and/or glass sampling. The Plan will include physical sampling requirements for batches, glass formulations, and/or feed envelopes.

III.11.I.4 DBVS Bulk Vitrification Waste Acceptance Criteria

III.11.I.4.a Bulk Vitrification waste forms that are acceptable to be disposed of at IDF are up to 50 boxes of vitrified glass produced pursuant to the DBVS Research, Development, and Demonstration (RD&D) Permit from processing Hanford Tank S-109 tank waste.

III.11.I.4.b If Bulk Vitrification is selected as a technology to supplement the WTP, the IDF portion of the Permit will need to be modified to accept Bulk Vitrification Full Scale production waste forms. This modification will need to be accompanied by appropriate TPA changes (per M-062 requirements) and adequate risk assessment information sufficient for the Department of Ecology to meet its SEPA obligations.

III.11.I.4.c DBVS Waste Acceptance Verification will occur on 100% of the waste packages. Pursuant to the DBVS RD&D Permit, a detailed campaign test report will be produced and submitted to Ecology detailing results of all testing performed on each waste package that is produced. IDF personnel shall review these reports to verify that the waste packages meet IDF Waste Acceptance Criteria.

III.11.I.4.d The Permittees shall not dispose of any waste forms that do not comply with all appropriate and applicable treatment standards, including all applicable LDR.

III.11.I.5 Modeling – Risk Budget Tool

III.11.I.5.a The Permittees must create and maintain a modeling - risk budget tool, which models the future impacts of the planned IDF waste forms (including input from analyses performed as specified in Permit Conditions III.11.I.2.a through III.11.I.2.a.ii) and their impact to underlying vadose and groundwater. This software tool will be submitted for Ecology review as soon as possible after issuance of Final Tank Closure and Waste Management EIS and receipt of underlying codes and data packages, and at least 180 days prior to the date DOE expects to receive waste at IDF. The risk budget tool shall be updated at least every 5 years. The model will be updated more frequently if needed, to support permit modifications or SEPA Threshold Determinations whenever a new waste stream or significant expansion is being proposed for the IDF. This risk budget tool shall be conducted in manner that is consistent with state and federal requirements, and represents a risk analysis of all waste previously disposed of in the entire IDF (both cell 1 and cell 2) and those wastes expected to be disposed of in the future for the entire IDF to determine cumulative impacts. The groundwater impact should be modeled to evaluate fate and transport in the groundwater aquifer(s) and should be compared against various performance standards including but not limited to drinking water standards (40 CFR 141 and 40 CFR 143). Ecology will review modeling assumptions, input parameters, and results and will provide comments to the Permittees. Ecology comments shall be dispositioned through the RCR process and will be reflected in further modeling to modify the IDF ILAW waste acceptance criteria as appropriate.

III.11.I.5.a.i The modeling-risk budget tool will include a sensitivity analysis reflecting parameters and changes to parameters as requested by Ecology.

III.11.I.5.a.ii If these modeling efforts indicate results within 75% of a performance standard (including but not limited to federal drinking water standards [40 CFR 141 and 40 CFR 143]), Ecology and the Permittees will meet to discuss mitigation measures or modified waste acceptance criteria for specific waste forms.

III.11.I.5.a.iii When considering all the waste forms to be disposed of in IDF, the Permittees shall not dispose of any waste that will result (through forward looking modeling or in real groundwater concentrations data) in a violation of any state or federal regulatory limit, specifically including but not limited to drinking water standards for any constituent as defined in 40 CFR 141 and 40 CFR 143.

III.11.I.6 The Permittees shall not dispose of any waste that is not in compliance with state and federal requirements as identified in Chapter 13.0.

III.11.I.6.a In accordance with DOE's authority under the *Atomic Energy Act of 1954*, as amended and other applicable law, prior to disposing of any mixed ILAW in the IDF, DOE will certify to the State of Washington that it has determined that such ILAW is not High-Level Waste and meets the criteria and requirements outlined in DOE's consultation with the U.S. Nuclear Regulatory Commission (USNRC) beginning in 1993 (Letter from R.M. Bernero, USNRC to J. Lytle, DOE, dated March 2, 1993; Letter from

J. Kinzer, USDOE, to C. J. Paperiello, USNRC, Classification of Hanford Low-Activity Tank Waste Fraction, dated March 7, 1996; and Letter from C.J. Paperiello, USNRC, to J. Kinzer, DOE, Classification of Hanford Low-Activity Tank Waste Fraction, dated June 9, 1997). While the requirement to provide such certification is an enforceable obligation of this Permit, the provision of such certification does not convey, or purport to convey, authority to Ecology to regulate the radioactive hazards of the waste under this permit.

III.11.I.7 IDF Operational Waste Acceptance Criteria.

III.11.I.7.a IDF operational activities (including decontamination, cleanup, and maintenance) will generate a small amount of waste. Waste that can meet IDF waste acceptance without treatment will be disposed of at the IDF. All other IDF operational waste will be managed pursuant to WAC 173-303-200.

INTEGRATED DISPOSAL FACILITY
CHAPTER 4.0
PROCESS INFORMATION

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
12/31/2008	

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CHAPTER 4.0
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CHAPTER 4.0
PROCESS INFORMATION

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APPENDICES

FIGURES

4.0 PROCESS INFORMATION

This chapter discusses the processes that will be used to dispose waste in the IDF and includes a discussion of the design and function of the following:

- Container
- Disposal landfill
- Leak detection system
- Leachate collection and removal system
- Secondary leak detection system

Note that the SLDS is not a design requirement of WAC 173-303-665, however DOE is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore, information regarding the design, construction, and operation of the secondary leak detection system is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under Resource Conservation and Recovery Act (RCRA) or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued there under. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes.

Waste stream compatibility (i.e., compatibility between individual waste streams and compatibility between waste streams and landfill design and construction parameters) will be assessed on a case-by-case basis. Criteria for assessing and determining compatibility is identified in the Waste Acceptance Criteria, Waste Analysis Plan, or other protocol or procedure as appropriate (Chapter 3.0, for further discussion of waste stream compatibility).

Process Code S01 (container storage) has been included within this permit, in the event that storage is required before final disposal (e.g., to support the confirmation process of the waste or cooling of vitrified waste if required). Waste failing the confirmation process (Chapter 3.0) will be identified as off-specification and may require storage prior to disposal. Only off-specification waste or vitrified waste requiring cooling (due to process heat) may be stored in the lined portion of the IDF pending disposition. To maintain operational flexibility, off-specification containers and vitrified waste requiring cooling could be left on the transport vehicles at the IDF until disposal can occur but may be off-loaded into the lined portion of the IDF pending final disposal provided the temperature administrative control limit is not exceeded. Off-specification waste and vitrified waste requiring cooling will be separated from other waste via tape, ropes, chains, or other cordon mechanism.

4.1 Containers

All mixed waste accepted for disposal at the IDF will be packaged in standard containers [U.S. Department of Transportation (DOT) and/or DOE], unless alternate packages are dictated by the size, shape, or form of waste (49 CFR 173) (e.g., metal boxes), and self-contained bulk waste.

4.1.1 Description of Containers

Mixed waste disposed at the IDF is limited to vitrified low-activity waste (LAW) from the RPP-WTP and DBVS. Additionally, mixed waste generated by IDF operations will be disposed of in IDF.

The RPP-WTP and DBVS containers are designed specifically for the vitrified low activity waste form. Nominal RPP-WTP container dimensions will be 122 centimeters base outside dimension, 107 centimeters top by 230 centimeters in length, with a wall thickness of 0.357 centimeter with a container volume of 2.55 cubic meters. The DBVS container dimensions are approximately 2.4 meters wide by 3.1 meters tall and 7.3 meters long and a container volume of 54 cubic meters. The vitrified low activity waste will be compatible with the containers, stainless steel for RPP-WTP and carbon steel for DBVS. Before receipt at the IDF, containers will be closed by the generator.

Due to the radioactivity and remote handling of the RPP-WTP immobilized waste containers, conventional labeling of the vitrified immobilized waste containers will not be feasible and an alternative to the standard labeling requirements will be used. This alternative labeling approach will use a unique alphanumeric identifier that will be welded onto each immobilized glass waste container. The welded "identifier" will ensure that the number is always legible, will not be removed or damaged during container decontamination, will not be damaged by heat or radiation, and will not degrade over time.

The identifier will be welded onto the shoulder and sidewall of each immobilized glass container at two locations 180 degrees apart. Characters will be approximately 2 in. high by 1.5 in. wide. The identifier will be formed by welding on stainless steel filler material at the time of container construction. This identifier will be used to track the container from receipt at the RPP-WTP, throughout its subsequent path of shipment and disposal at the IDF.

Each identifier will be composed of unique coded alphanumeric characters. This unique alphanumeric identification will be maintained within the plant information network, and will list data pertaining to the waste container including waste numbers, and the major risk(s) associated with the waste.

Mixed waste generated through waste operations at IDF will be packaged based on the size of the waste, with the most common container being galvanized or aluminized 208-liter containers.

The container packaging and handling for the IDF are designed to maintain containment of the waste, limit storage intrusion, and limit human exposure to mixed waste. Unusual sized containers such as vitrified LAW packages will be handled by using cranes or other appropriate equipment.

Operations personnel will inspect each container to confirm appropriate documentation and compliance with the waste acceptance criteria before the container is placed in the IDF (refer to Chapter 3).

If containerized mixed waste must be opened (i.e., for confirmation sampling, repackaging, etc.), the container typically would be removed to an onsite treatment and/or storage unit or other approved location before being opened. The container would be sealed before being returned to the IDF.

4.2 Leachate Collection Tanks

The aboveground leachate collection tanks support~~s~~ the lined IDF landfill. The leachate collection tanks will be operated in accordance with the generator provisions of WAC 173-303-200 and WAC 173-303-640 as referenced by WAC 173-303-200.

For informational purposes, the following is provided for an understanding of the operation of the Leachate Collection Tanks. Procedures will be written to manage the leachate in accordance with WAC 173-303-200. The presence of leachate in the tanks will be detected with instrumentation within ~~the~~ two stilling wells in each tank. The level instrument within the first stilling well monitors the depth of leachate in the tank. A second stilling well will have instrumentation for high-high and low-low alarm set-point trips. The leachate will be removed from the tanks using a transfer pump.

The Leachate Collection Tanks have fabricated dome covers. Piping connecting the leachate transfer buildings allows leachate to be pumped from each cell into either tank. Designs for the fabricated dome covers and leachate tank transfer pipline are discussed in Appendices 4A and C9.

4.3 Landfills

The following addresses the IDF lined landfill.

4.3.1 List of Wastes

IDF will receive mixed and/or dangerous waste.

Waste will be accepted in containers (e.g. drums, boxes, larger containers).

Waste streams acceptable at the IDF facility fall within the range of dangerous waste numbers identified in Chapter 1.0, Part A Form.

4.3.2 Liner System Exemption Requests

This permit documentation does not seek an exemption to liner system requirements.

4.3.3 Liner System, General Items

This section provides a general description of the liner system to be used for the IDF lined landfill.

The liner system was designed to prevent migration of leachate out of the lined landfill during the active life of the landfill. The Active Life will consist of the operational period and the closure/postclosure period. The liner system was designed to meet U.S. Environmental Protection Agency (EPA) requirements, as identified in RCRA Subtitle C requirements for hazardous waste disposal facilities (40 CFR 264), technical guidance documents (e.g., EPA 1985), and WAC-173-303-665. In addition, the liner system incorporates the following general functional requirements:

- Range of Operating Conditions--year-round operation, withstand construction, and long-term stresses.
- Degree of Reliability--function safely and effectively throughout operating and closure/postclosure period with minimum maintenance.
- Intended Life--operational phase plus closure/postclosure monitoring phase.

4.3.3.1 Liner System Description

The landfill liner system will comply with WAC 173-303-665 requirements for dangerous waste landfills. Figure 4.2 shows a typical design and includes the following components (from top to bottom).

- Operations layer: minimum 0.9-meter thick of native soil. This layer provides a working surface for equipment, protect the liner from mechanical damage, and prevent freezing of the underlying low-hydraulic conductivity soil layer. (Hydraulic conductivity is a measure of how rapidly a material can transmit water and is based on specific ASTM testing requirements.)
- Leachate collection and removal system (LCRS) contains a minimum 0.3-meter-thick drainage gravel layer with a hydraulic conductivity of at least 1×10^{-2} centimeter per second (sometimes including perforated drainage pipes). A nonwoven separation geotextile is located between the operations layer and the drainage gravel layer to minimize sediment (fine-soil) migration into the LCRS. A nonwoven cushion geotextile is located between the drainage gravel and the primary geomembrane to protect the primary geomembrane.

The LCRS liners collect and convey leachate to the LCRS sump for removal and include the following components.

- Primary geomembrane liner: this liner consists of high-density polyethylene (HDPE) because of its excellent resistance to expected chemicals (Chapter 1.0), nominal 60-mil thickness (54-mil minimum), which is textured (to improve stability against sliding). The geomembrane acts as a moisture barrier. Located immediately above the primary geomembrane the LCRS includes a perforated pipe that helps collect and guide water into the leachate collection sump. The perforated pipe is located along the centerline of the cell and provides high-flow path water to the primary collection sump.
- Primary geosynthetic clay liner (GCL): the GCL consisting of a high-swelling sodium synthetic mat containing bentonite with a hydraulic conductivity of 1×10^{-8} centimeter per second or less. This layer acts as an additional primary moisture barrier directly under the primary geomembrane.

The leak detection system (LDS) is similar to the LCRS except the composite drainage net (CDN) replaces the primary gravel layer, the geosynthetic clay liner (GCL) is placed directly under the secondary geomembrane liner only under the LDS sump and the perforated pipes are not be needed because very high flow capacities are not be required.

The purpose of this system is to collect any leachate that leaks through the primary liner system and convey the leachate to the LDS sump for removal. The LDS also serves as a secondary LCRS. The LDS liners will collect and convey leakage to the LDS sump and include the following components:

- Secondary geomembrane liner: same as primary geomembrane liner.
- Secondary geosynthetic clay liner: same as primary geosynthetic clay liner.
- Admix liner: a minimum 0.9-meter-thick layer of compacted soil/bentonite admixture with a hydraulic conductivity of 1×10^{-7} centimeter per second or less. The bentonite is high-swelling sodium bentonite. This layer acts as an additional moisture barrier directly under the secondary geosynthetic clay liner in the LDS sump area and the secondary geomembrane outside the LDS sump area.
- The secondary leak detection system (SLDS) consists of operations layer type fill for a foundation of the LDS admix layer, drainage gravel with a hydraulic conductivity of at least 1×10^{-2} centimeter per second adjacent to a perforated pipe, a composite drainage net (CDN) and tertiary geomembrane. A nonwoven separation geotextile is located between the operations layer type material and the drainage gravel to minimize sediment (fine-soil) migration into the SLDS piping. The purpose of this system is to provide access to the area immediately below the LDS sump area. The SLDS collects liquids resulting from construction water and potentially, liquid from other sources. The SLDS liners will convey collected liquids to the SLDS piping for monitoring and/or removal. (Note that the secondary leak detection system is not a design requirement of WAC 173-303-665, however DOE is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore, information regarding the design, construction, and operation of the secondary leak detection system is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under RCRA or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued there under. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes).

4.3.3.1.1 Operations Layer

The purpose of the operations layer is to protect the underlying liner components from damage by equipment during lined landfill construction and operation. This layer also protects the admix layer from freezing and desiccation cracking.

Previous research and experience has shown that desiccation cracks can occur under geomembrane liners when either the liner is not in close contact with the compacted admix or when the liner is subjected to wide temperature fluctuations (Corser and Cranston 1991). The operations layer acts as a weight to keep the geomembrane in contact with the admix, thereby reducing the potential for water vapor to form in an underlying airspace. The operations layer also acts as an insulating layer, together with the dead air space trapped in the underlying drainage layers.

The operations layer material typically consists of onsite granular soil that is reasonably well graded. The material has a maximum particle size limit of 5.1 centimeters or less, to facilitate protection of the underlying layers.

4.3.3.1.2 Leachate Collection and Removal System

The LCRS is located below the operations layer and provides a flow path for the leachate flowing into the LCRS sump.

Between the operations layer and the underlying drainage gravel, a geotextile layer functions as a filter separation barrier. The geotextile prevents migration of fine soil and clogging of the drainage gravel. On the lined landfill floor the drain gravel is a minimum 0.3-meter-thick layer of washed, rounded to subrounded stone, with a hydraulic conductivity of at least 1×10^{-2} centimeter per second. In addition, a perforated high-density polyethylene drainage pipe placed within the drainage gravel accelerates leachate transport into the LCRS sump during high precipitation events. On the lined landfill floor, the drain gravel layer is underlain by a geotextile cushion resting on the primary high-density polyethylene geomembrane. The geotextile provides additional protection for the primary geomembrane on the floor of the landfill.

On the lined landfill sideslopes, the LCRS has a composite drainage net (CDN) layer composed of a geonet (which is a network of HDPE strands, interwoven and bonded to form a panel that provides a drainage pathway for fluids), with a layer of geotextile thermally bonded to each side. This CDN layer has a transmissivity of at least 3×10^{-5} meters squared per second. The CDN is used on the sideslopes to avoid problems associated with placement of clean granular material on slopes, thereby minimizing the potential for damaging the underlying liner system.

4.3.3.1.3 Primary Geomembrane Liner

The primary geomembrane liner acts both as an impermeable leachate barrier and as a flow surface, routing leachate to the primary sump. High-density polyethylene was used because of its high resistance to chemical deterioration. Generally, textured (roughened) geomembrane is used to maximize shear strength along adjacent interfaces and to reduce the potential for sliding of the liner system.

4.3.3.1.4 Primary Geosynthetic Clay Liner Layer

A primary geosynthetic clay liner (GCL) consists of a mat of bentonite placed between two geotextiles. The GCL is installed immediately beneath the primary high-density polyethylene liner on the floor of the lined landfill only. The purpose of this liner is to provide extra protection in the case of deterioration (such as stress cracking) of the primary geomembrane where operations will continue for several years.

The in-place hydraulic conductivity of the GCL is 1×10^{-8} centimeter per second or less, exceeding the WAC hydraulic conductivity requirement for the secondary soil liners. The upper surface of GCL provides a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.5 Leak Detection System

The LDS provides the flow path for leachate flowing into the LDS sump. The following is a description of the system to be used in the IDF landfill.

The LDS has a CDN drainage layer on the floor, and a CDN drainage layer on the sideslopes. The CDN consist of a layer of geotextile thermally bonded to each side of the geonet. These materials and their configuration is similar to the LCRS described in Section 4.3.3.1.2, except for the absence of a drainage gravel layer and a perforated drainage pipe system on the floor of the lined landfill. The LDS will channel leachate that penetrates the primary liner system through the CDN into the leak detection sump.

The LDS serves as a secondary LCRS for the IDF. Leachate collected in the secondary sump will be measured to determine the leakage rate through the primary liner.

4.3.3.1.6 Secondary and Tertiary Geomembrane Liner

The secondary geomembrane liner, located underneath the LDS, is placed directly against the secondary compacted admix liner, except in the LDS sump area which includes a geosynthetic clay liner between the secondary geomembrane liner and the secondary compacted admix liner. For information only, the teriary geomembrane liner for the SLDS is placed directly against subgrade as per Section 4.3.3.1.8. The secondary and teriary geomembrane liners are similar to the primary geomembrane described in Section 4.3.3.1.3. The secondary geosynthetic clay liner material is similar to the primary geosynthetic clay liner described in Section 4.3.3.1.4.

4.3.3.1.7 Secondary Admix Liner

The secondary admix liner has a minimum 0.9-meter-thick compacted soil/bentonite admixture located immediately beneath the secondary high-density polyethylene liner, as required by WAC 173-303-665. The secondary admix liner typically consists of silty sand from local borrow sources mixed with a nominal 12 percent sodium bentonite, by dry weight. The in-place hydraulic conductivity of the admix liner is 1×10^{-7} centimeter per second or less, consistent with WAC requirements for secondary soil liners. The upper surface of the secondary admix liner is trimmed to the design grades and tolerances. The surface was rolled with a smooth steel-drum roller to remove all ridges and irregularities. The result is a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.8 Subgrade/Liner System Foundation

The lined landfill in the IDF is founded in undisturbed native soils or material compacted to at least 95% of a standard proctor maximum density (determined by ASTM D698). The liner system foundation is discussed in further detail in Section 4.3.4.

4.3.3.1.9 Access Ramp

The lined landfill has an access ramp outside the lined portion of the landfill, minimizing damage to the liner system from vehicle traffic into the lined landfill. As the landfill expands the access ramp will be reconstructed to the south of each expansion in the landfill. The access ramp design could vary as the landfill expands.

4.3.3.1.10 Landfill Expansion

The initial phase of the IDF liner was complete at the north end of the landfill. As shown in Figure 4.1, construction of the initial IDF phase completed the liner system on the north sideslope and the excavated portions of the landfill floor, east sideslope, and west sideslope. The dashed line of Figure 4.1 across the south edge of the landfill floor denotes the southern extent of the landfill liner. The liner system will be installed to extend approximately 15 meters beyond the estimated toe of slope of the first phase waste placement. This extension will also allow waste haul vehicles to be staged or unloaded over a lined area. Termination detail for the south edge of the liner system is found in Appendix 4A, drawing H-2-830840. The south sideslope of the first phase of IDF is not lined to allow future expansion of the IDF. At the south end of the cells is a storm water berm/ditch with an infiltration area, which will capture clean runoff from the unlined south sideslope before it runs onto the lined landfill. The landfill floor slopes up 1% from north to south to allow adequate leachate collection capacity for a 25-year storm event. Each future liner construction project will connect to the south edge of the previously constructed liner and operations systems and extend the disposal area further to the south. With the expansion of the IDF in subsequent phases, access ramps for the previous phase will be destroyed and new ramps built on the south edge of the landfill.

4.3.3.2 Liner System Location Relative to High Water Table

The water table is located approximately 90 to 100 meters below the ground surface in the IDF. It is anticipated that the deepest point of the liner system is no greater than 20 meters below ground surface. Consequently, the liner systems is at least 69 meters above groundwater. The liner systems will not be affected by the water table because of this large elevational difference.

4.3.3.3 Loads on Liner System

The liner system experiences several types of stresses during construction, operation, and closure/postclosure periods. The following sections discuss the types of stress and analytical methods used to design the IDF liners.

4.3.3.3.1 Liner Stress

The geosynthetic liner components experience some stress particularly during installation and before placing waste in the lined landfill but also during the entire lifecycle.

The high-density polyethylene liner is temperature sensitive, expanding, and contracting as liner temperatures increase and decrease. Thermally induced stresses could develop in the liner if deployment and anchoring occur just before a significant decrease in the liner temperature. The operations layer is sufficiently thick to ensure liner stress remains below the yield strain and stress. Administrative procedures will prevent loading and backfilling of waste exceeding applicable thermal limits due to recent vitrification processes to avoid potential liner damage.

The drainage gravel has the potential to produce localized stress on the geomembrane liner during gravel placement with construction equipment. The geotextile cushion placed at the base of the drainage gravel protects the underlying geomembrane. A puncture analysis was performed to select a sufficiently thick cushion geotextile. This analysis incorporated expected construction vehicle ground pressures and design drainage gravel gradation listed in the construction specifications. If required, engineering controls such as independent foundations will be installed to minimize liner stress involved with large package disposal.

On the landfill sideslopes, tension induced by liner-component load transfer is not anticipated, because the liner interface effective shear strength angles are higher than the sideslope angles. The liner component interface strengths were determined by laboratory direct shear tests. Both static and dynamic stability analyses were performed, using standard methods, design accelerations, and factors of safety.

Stress on the geomembrane in the anchor trench also was evaluated during detailed design. Wind uplift and thermal expansion and contraction could cause stress in the geomembrane during construction. However, these stresses are not be a problem, because the stress is relatively low as compared to the tensile strength of the liner. In addition, these stresses are minimized by using sand bags to control liner position during liner panel placement and welding, as well as keeping the anchor trench open until the liner is stabilized with overlaying fill material. Placement of overlaying fill material is controlled to limit stress buildup in the liner. The stress is not present after construction, because of the weight and insulating properties of the operations layer.

4.3.3.3.2 Stress Resulting From Operating Equipment

Operations equipment provides a design load case on the IDF liner, which was analyzed as part of the IDF design (Appendix 4A). The analyses show that the 0.9-meter-thick operations layer dissipates stress produced by the operating equipment and is sufficient to protect the IDF liner system.

4.3.3.3.3 Stress from Maximum Quantity of Waste, Cover, and Proposed Closure/Postclosure Land Use

When the lined landfill is full and the cover system is in place, the liner system will experience a static load from the overlying waste, backfill, and cover materials. No significant increase in stresses on the liner system is anticipated from closure/postclosure land use. The maximum design load of material overlying the liner system includes an allowance for the cover system. Analyses include puncture protection of the geomembrane by the cushion geotextile, and decrease in transmissivity of CDN drainage layers. Materials were specified based on the ability of the materials to perform adequately under closure/postclosure loading conditions.

Dynamic stress on the liner system will result primarily from ground accelerations during seismic events. Both static and dynamic analyses were performed on the subgrade and liner components based on the finished configuration of the empty landfill. Under closure/postclosure conditions, the waste, backfill, and cover materials will tend to buttress the liner system, resulting in greater stability relative to the operational phase. All of the analyses verified adequate stability for the IDF.

4.3.3.3.4 Stresses Resulting From Settlement, Subsidence, or Uplift

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade rebounded during the excavation phase of construction and will settle as the landfill is filled. The compacted admix liner will consolidate under waste loads. The total settlement will be a combination of the subgrade elastic and the admix consolidation settlements.

These settlements were analyzed with standard methods during detailed design of the lined landfill. In general, differential settlements will be expected to occur primarily across the lined landfill sideslopes as the thickness of waste decreases from maximum to zero. The geosynthetic liner components were analyzed, the anticipated strains likely will not produce any appreciable stresses in the liner system.

The potential for subsidence-induced stress is believed to be negligible based on the following information:

- The soils underlying the IDF tend to be coarse-grained soils, sands, and gravels, in a relatively dense configuration that will not be subject to piping effects that could transport soil resulting in subsidence.
- The groundwater level is deep, at least 69.6 meters below the base of the lined landfill, and will not affect bearing soils.
- No natural voids, or man-made mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater below the lined landfill.

The potential for stresses resulting from uplift on the liner system also is expected to be negligible. The seasonal groundwater level is very deep, and higher-elevation perched groundwater likely will not develop because of the absence of aquitards in the coarse-grained Hanford formation underlying the IDF. The coarse-grained nature of the Hanford formation also promotes rapid, primarily vertical, infiltration, which means it is unlikely that infiltration from outside the lined landfill boundary would be transported laterally underneath the landfill liner. Gas pressures similarly are unlikely to develop because of the absence of any organic material that could generate significant subsurface gas (from organic material decomposition) and the coarse-grained, highly permeable sands and gravels underlying the landfill.

4.3.3.3.5 Internal and External Pressure Gradients

Pressure gradients across the liner caused by liquids or gases will be expected to be negligible. Internal pressures due to liquids will be controlled by the leachate collection and removal system. Because leachate will be removed from the flat 50-foot by 50-foot LCRS sump in a timely manner, there will be minimal liquid head on the liner (less than 30.5 centimeters according to WAC regulations). Gas generated internally is expected to be minimal because waste is inorganic and non-reactive. However, any pre-closure internally generated gas will be vented through either the waste or the leachate collection system. The closure cover design will consider gas venting.

External pressures on the liner system is expected to be minimal. Gas pressures will be negligible because the subgrade soil contains no gas producing materials and is highly permeable, readily venting any potential gas to the atmosphere. External pressure from liquids is not anticipated because of the deep groundwater table and the highly permeable foundation soils.

4.3.3.4 Liner System Coverage

The liner system covers all soils underlying the lined landfill and extends over the crest of the sideslopes into the anchor trench (Figure 4.2, Detail 3).

4.3.3.5 Liner System Exposure Prevention

No geosynthetic or admix components of the liner system are exposed to the atmosphere. The minimum 0.9-meter-thick operations layer covers the entire lined landfill surface. This layer serves both as a physical protective barrier and as thermal insulation, protecting the admix layer from desiccation and frost damage.

Excessive erosion, such as gullying, will be repaired by replacing the eroded soil. Dust suppression agents will be used to prevent excessive wind erosion on the landfill sideslopes. The dust suppression agents will bind the surface of the operations layer and will minimize wind entrainment of soil.

4.3.4 Liner System, Foundation

The following sections discuss the foundations beneath the liner systems.

4.3.4.1 Foundation Description

At the IDF, the Hanford formation consists mainly of sand dominated facies with lesser amounts of silt dominated and gravel dominated facies. Where sands are present, these sands are underlain by the Hanford formation. Here, the Hanford formation has been described as poorly sorted pebble to boulder gravel and fine to course grained sand, with lesser amounts of interstitial and interbedded silt and clay.

The two geologic units pertinent to the IDF lined landfill are summarized as follows.

Recent eolian sand: The sand is light olive gray in color and has a density that is loose at the surface but becomes compact with depth. The sand has a fine to medium grain size and includes little to some nonplastic silt-sized fines. The deposit is homogeneous except for a distinguishable layer of volcanic ash in some locations.

Glaciofluvial flood deposit: This deposit has well graded mixtures of sands and gravels with trace to little nonplastic silt-sized particles. The gravel content can vary with depth, and the deposit can become predominantly gravel. This coarse-grained deposit is part of the Cold Creek Bar, which was formed during the Pleistocene Epoch by glacial outburst flooding.

4.3.4.2 Subsurface Exploration Data

Geological site investigations were used to support the detailed design of the landfill. The investigations consisted of a review of historical data, including well logs (Chapter 5.0), exploratory borings, and surface pit samples data. Because the foundation soils are relatively consistent over broad areas, the need for additional borings and geophysical investigations will be determined on a case-by-case basis. If boreholes are drilled, penetration test data will be collected to determine the strength of the foundation materials in situ.

4.3.4.3 Laboratory Testing Data

Laboratory testing will be performed on the surface soil samples and borings, both from the lined landfill site and from potential borrow source locations as follows. Testing will be performed to classify soils, provide input parameters to verify engineering analyses, and for preparing material and construction specifications. The following tests will be performed on the soil samples:

- Visual classification (ASTM D2487)--to classify soils
- Natural moisture content (ASTM D2216)--for input to engineering analyses and preparing construction specifications
- Particle size analysis (ASTM D422 or D1140/C136)--for classification and input to engineering analyses
- Moisture-density relationships (ASTM D698 or D1557)--for preparing compaction specifications

Laboratory testing will be performed according to the most recent versions of ASTM methods or other recognized standards. Additional tests will be performed as needed.

4.3.4.4 Engineering Analyses

The subgrade will be required to support the liner system and overlying materials (waste, fill, and cover) without excessive settlement, compression, or uplift that could damage the liner system. This section describes the design approach used to satisfy these criteria.

4.3.4.4.1 Settlement Potential

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade will rebound during the excavation phase of construction and will settle as the landfill is filled.

An elastic settlement analysis using standard methods was performed and results indicate the magnitude of the total and differential settlement is within performance limits.

4.3.4.4.2 Bearing Capacity

The bearing capacity of the subgrade soil will need to support structures such as leachate collection tanks. The construction specifications typically will require that the upper portion of the subgrade soil and all structural fill be moisture conditioned and compacted to at least 95 percent of the maximum standard Proctor dry density (ASTM D698). Maximum allowable bearing capacities for foundations have been established using standard geotechnical methods. Bearing capacities for the types of soils expected at the IDF typically are greater than the maximum expected loads from the support structures.

4.3.4.4.3 Stability of Lined Landfill Slopes

The lined landfill was constructed in eolian sand and the underlying coarse-grained Hanford formation. In granular, cohesionless, and drained soils such as these, the stability of the slope will be related primarily to the maximum slope angle. Both veneer and global stability analyses were performed to determine both static and dynamic sideslope stability. Results demonstrate adequate stability for the IDF throughout its design life.

4.3.4.4.4 Potential for Excess Hydrostatic or Gas Pressures

Because the seasonal high-water level is at least 69 meters below the base of the deepest lined landfill, no external hydrostatic pressure will be expected from this source. Because of the coarse-grained nature of the foundation soils, any infiltration of surface water around the perimeter of the lined landfill will be expected to travel primarily downward. Therefore, infiltration should not cause substantial pressure on the exterior of the liner system. Internal hydrostatic pressure from leachate will be negligible because the leachate will be removed from the lined landfill to limit head on the liner.

Gas pressure exerted externally on the liner system is expected to be negligible, because no gas-generating material (i.e., organic material) is expected in the foundation soils. If any gas were generated below the liner system, little pressure buildup would occur because of the unsaturated coarse-grained nature of the foundation soils, which would vent the gas to the atmosphere. Internal gas pressure buildup will not be anticipated, because wastes are generally inorganic and have low gas generating potential, and the leachate collection system will be vented to the atmosphere and dissipates any gas.

4.3.4.4.5 Seismic Conditions

Potential hazards from seismic events will include faulting, slope failure, and liquefaction. Disruption of the lined landfill by faulting is not considered a significant risk because (1) no major faults have been identified at the IDF (DOE/RW-0164) and (2) only one central fault at Gable Mountain on the Hanford Site shows evidence of movement within the last 13,000 years. The potential for slope failure is considered low, because granular materials typically have high strengths relative to the maximum sideslope angles expected for the lined landfill. Liquefaction will occur in loose, poorly graded granular materials that are subjected to shaking from seismic events. Saturated soils will be most susceptible because of high dynamic pore pressures that temporarily lower the effective stress. During this process, the soil particles will be rearranged into a denser configuration, with a resulting decrease in volume. The foundation materials at the IDF is not considered susceptible to liquefaction because the materials are well graded granular soils that are unsaturated and relatively dense.

The IDF support building (not sited within the TSD boundary) will be located in Zone 2B as identified in the Uniform Building Code (ICBO 1997).

4.3.4.4.6 Subsidence Potential

In general, subsidence of undisturbed foundation materials would be the result of dissolution, fluid extraction (water or petroleum), or mining. The potential for subsidence will be negligible at the IDF based on the following.

- The soils underlying the IDF are coarse-grained sands and gravels, in a relatively dense configuration, which are not subject to piping that can cause transport of soil and resulting subsidence.
- The groundwater level is deep, at least 69 meters below the base of the lined landfill, and does not affect bearing soils.
- The soil and rock types below the IDF are not soluble.
- No mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater table below the lined landfill.

4.3.4.4.7 Sinkhole Potential

Borings in and around the IDF have not identified any soluble materials in the foundation soils or underlying sediments. Consequently, the potential for any sinkhole development is negligible.

4.3.5 Liner System, Liners

The following sections discuss the individual components of the IDF liner systems.

4.3.5.1 Synthetic Liners

As described in Section 4.3.3, the synthetic liners act as an impermeable barrier for leachate migration (Figure 4.2). The synthetic liners consist of high-density polyethylene material that make the liners resistant to chemical deterioration. Section 4.3.3 describes the synthetic liner system in detail.

4.3.5.2 Synthetic Liner Compatibility Data

During detailed design of the lined landfill, the composition of the expected leachate was estimated. Expected leachate composition was based on known waste composition, process information, leachate from other operating lined landfills, and similar sources of data. Leachate constituents were compared to manufacturers' chemical compatibility data for synthetic liner components. In addition, the results of previous chemical compatibility testing and studies were evaluated against leachate composition. Information gained from this evaluation was used to select a liner that will be compatible with the expected leachate.

Compatibility testing for leachate tank liner material is planned for construction. An immersion test program is included in the technical specifications for the tank liner (anticipated to be XR-5 material). The immersion-testing program will require the construction general contractor to submit tank liner samples to the design engineer for immersion testing as part of the submittal and certification process for the tank. Immersion testing will follow EPA 9090A (and ASTM) test protocols.

During landfill operation, the compatibility of waste receipts with the liner will be ensured. The compatibility of the waste constituents with the liner material will be established by laboratory testing if determined to be necessary, based on waste type and concentrations. Such tests will follow EPA Method 9090A or other appropriate methods. Test results will be evaluated using statistical methods and accepted criteria (based on past projects and agency acceptance) for liner/leachate compatibility.

4.3.5.3 Synthetic Liner Strength

As discussed in Section 4.3.3.3, the liner system will experience loads from several sources. During the detailed design process for the landfill, the strength of liner system materials was evaluated against these loads. The analysis indicated an adequate factor of safety for liner system materials.

Seams in geomembranes is a critical area; however, correct installation methods make the seams stronger than the surrounding material. Detailed installation and testing requirements will be included in the construction quality assurance plan (Section 4.3.7.3) to ensure that the liner is constructed properly. In addition, methods will be established to demonstrate adequate seam strength is achieved during installation.

Seaming requirements for the geotextiles and CDN: These materials were overlapped sufficiently to provide complete area coverage, and relatively light seams were used to hold the panels in position during construction, seam strength requirements for these materials will be negligible.

4.3.5.4 Synthetic Liner Bedding

The primary geomembrane liner is in contact with the GCL and geotextile cushion underlying the drainage gravel.

The secondary geomembrane liner is in direct contact with the compacted admix layer. This type of subgrade is typical for flexible geomembrane liners.

With respect to the drainage gravel and operations layers, the geomembranes are protected by overlying geotextile cushion or CDN layers. These geotextiles were designed to provide adequate protection during construction and operation to withstand the loads discussed in Section 4.3.3.3.

4.3.5.5 Soil Liners

The IDF landfill is lined with a minimum (0.9-meter thick) layer of compacted soil/bentonite mixture (admix) under the secondary geomembrane liner. This layer has an in-place hydraulic conductivity of less than 1×10^{-7} centimeter per second. The soil component of the admix is silty fine sand or similar material from areas near the IDF. Approximately 12 percent bentonite by dry weight was added to the fine soil to achieve sufficiently low hydraulic conductivity; however, the percent might vary.

4.3.5.5.1 Material Testing Data

Laboratory testing will be performed on soil liner materials to confirm input parameters for engineering analyses and for refining material and construction specifications.

Before constructing the lined landfill, a full-scale test fill of the admix material will be conducted. The primary purpose of the test fill will be to verify that the specified soil density, moisture content, and hydraulic conductivity values will be achieved consistently using proposed compaction equipment and procedures. In-place density will be measured using both the nuclear gauge (ASTM D2922) and sand cone (ASTM D1556) methods. In-place hydraulic conductivity will be determined from a two-stage infiltration from a borehole (ASTM D6391). Admix hydraulic conductivity will be estimated from thin-wall tube samples (ASTM D1587) obtained from the test fill and tested in the laboratory (ASTM D5084). Details of the test fill are presented in the Construction Quality Assurance Plan (Appendix 4B). During construction, field density (e.g., ASTM D2922, D2167, and/or D1556) and moisture content (ASTM D2216) will be measured periodically. Thin-wall tube samples (ASTM D1587) will be taken at regular intervals and will be tested for hydraulic conductivity (ASTM D5084). Additional details of field-testing during construction will be presented in the Construction Quality Assurance Plan.

Dispersion and piping in the admix are not considered likely because the hydraulic conductivity, and thus the flow velocity, will be very low, making it difficult to move the soil particles or otherwise disrupt the soil fabric. In addition, the admix will be well graded, so the component particles will tend to hold each other in place. Therefore, testing for these characteristics will not be necessary.

4.3.5.5.2 Soil Liner Compatibility Data

As discussed in Section 4.3.5.2, expected leachate composition was determined as part of detailed landfill design. The results of previous chemical compatibility testing and studies were evaluated against leachate composition to determine the effect of leachate on soil liner composition or hydraulic conductivity. The tests followed the procedures of ASTM D5084 (flexible wall parameter) and considered the effects of radiation on the soil liner materials.

4.3.5.5.3 Soil Liner Thickness

The IDF was designed to operate to minimize the leachate head over the liner systems.

Design of the primary liner system included an additional clay layer (the primary GCL layer, which was previously described in Section 4.3.3.1) underlying the primary HDPE geomembrane to further minimize liner leakage from the primary liner. Note that only a single geomembrane is required under WAC 173-303 for the primary liner.

Calculations evaluated the effectiveness of the primary soil liner as a barrier to leachate. Leakage analyses were performed for the primary liner system using EPA's Hydrologic Evaluation of Landfill Performance (HELP) Model (Schroeder et al. 1997). Estimated leakage rates were compared to the Action Leakage Rate (ALR, which is defined in WAC 173-303-665[8] as "the maximum design flow rate that the leak detection system … can remove without the fluid head on the bottom liner exceeding 1 foot"), and were determined to be much lower than the ALR. This demonstrates the benefit of the GCL included in the primary bottom-lining system, which provides a composite lining system and minimizes actual leakage through the bottom primary lining system.

Overall, the IDF is designed to actively convey and collect leachate from the liner areas of the facility to minimize leachate buildup over the liners. Leachate is conveyed to the LCRS and LDS sumps for active removal from the facility. In addition, the LCRS sump area has been designed with a 6-inch-deep sump trough where the LCRS pumps are positioned to minimize the area of the sump that has a permanent liquid level (below the pump intake/shutoff elevation). Both the LCRS and LDS sump pumps will be operated throughout the Active Life of the facility and into the post-closure period until leachate generation has essentially ceased. By actively removing leachate from the IDF, head buildup is minimized, which in turn minimizes leakage through both the primary and secondary liner systems.

4.3.5.5.4 Soil Liner Strength

The expected loads on the liner system are discussed in Section 4.3.3.3. Significant stresses in the soil liner that were considered include (1) stresses from the weight of the liner system, (2) stresses on the interface with the overlying materials, and (3) stresses during construction.

Stresses will be present on the sideslopes from the weight of the operations layer and soil liner itself. Using material properties determined from laboratory testing, the stability of the soil liner was evaluated under both static and dynamic loading conditions. Standard methods of slope stability analysis were used. Interface strengths were found to provide adequate veneer stability for the liner system. Interface strength is the shear strength that occurs between layers of liner materials at their interface boundary, as established by ASTM test methods.

The primary concern during construction will be bearing failure caused by the weight of overlying soil components of the liner system (e.g., drainage gravel on the floor) and the construction equipment used to spread these materials. Strength parameters developed from laboratory testing and standard analytical methods were again used to determine that adequate stability and bearing capacity exist for the IDF liner system.

4.3.5.5.5 Engineering Report

An engineering report was prepared for the lined landfill as part of the definitive design document package. The report describes the design of the liner system and includes supporting calculations.

The critical systems IDF Design Report is provided in Appendix 4A. The final IDF design report was prepared under the supervision of a professional engineer registered in Washington State.

4.3.6 Liner System, Leachate Collection and Removal System

The purpose of the leachate collection and removal system is to provide sufficient hydraulic conductivity and storage volume to collect, retain, and dispose of, in a timely manner, fluids falling on or moving through the waste. The primary leachate collection and removal system provides the preferential path along which the leachate flows into the primary sump. The secondary leachate collection and removal system (also called the leak detection system) is located between the primary and secondary geomembranes. The secondary leachate collection and removal system provides the preferential path along which any fluids leaking through the primary liner system flow to the secondary sump.

The collected leachate will be pumped to a leachate collection tank, screened and/or sampled, and transferred to a permitted treatment and disposal unit.

4.3.6.1 System Operation and Design

The lined landfill operates in a way that ensures the bottom liner is maintained as dry as possible, and the head on the top liner does not exceed 30.5 centimeters measured above the flat 50-foot-by-50-foot LCRS sump HDPE liner. In extreme conditions (i.e., in excess of a 25-year storm event), the head on the top liner could exceed 30.5 centimeters for short durations. The operating methodology, described in the following paragraphs, ensures that liquids on the bottom liner are removed continuously before liquids could accumulate and exceed 30.5 centimeters for the design storm event.

Both leachate collection systems operate either manually or automatically. When operated automatically, liquid level sensors will cycle the pumps on and off, in response to rising and falling leachate levels. The leakage rate through the top liner will be calculated to demonstrate that the leakage rate is less than the 'action leakage rate'. Data to support the leakage rate calculations will be obtained either from the flow totalizer in the secondary leachate collection pump discharge line or from the liquid level gauges. Collected leachate from the secondary leachate collection system is pumped to the leachate collection tank.

The design of the primary and secondary leachate collection systems is described in Section 4.3.3.1. System geometry was completed and material specifications were developed during the detailed design process. The leachate collection and removal system design will comply with WAC 173-303 requirements and applicable guidance.

Each sump has a thick layer of gravel designed to provide high hydraulic conductivity and storage capacity. Leachate is removed from the sumps by a pump installed in sideslope riser pipes. Pressure transducers monitor leachate level in the sumps and provide appropriate signals to the pump control system. All pumps and transducers are removable for maintenance, calibration, and related activities.

4.3.6.1.1 Primary System

The base of the leachate collection and removal system is defined by the primary geomembrane. On the floor of the lined landfill, the primary geomembrane is overlain by geotextile cushion, and the granular drainage layer. The granular drainage layer drains to the primary sump and a perforated pipe is located along the centerline of the cell to increase flow capacity to the primary sump. Geotextile layers at the top of the leachate collection and removal system prevent migration of fine soil particles into the gravel or geonet, thus prevent clogging. On the sideslopes, a CDN layer is over the geomembrane. The CDN includes bonded geotextiles on both sides of a geonet that increase the interface shear strength. Because of construction difficulties in placing a 30.5-cm thick gravel layer on 3:1 sideslopes, no drainage gravel was placed on the sideslopes.

The leachate collection and removal system is covered by the operations layer. The layer is a minimum 0.9-meter thick, and provides protection for the underlying liner and drainage materials. The operations layer covers both the landfill floor and the sideslopes.

The leachate collection and removal system was designed to accommodate the 25-year, 24-hour storm, as required by WAC regulations. However, the EPA recognizes the need to store temporarily leachate from such rare events (EPA 1985). Should a storm event that exceeds the 25-year, 24-hour storm event occur, the leachate collection and removal system sump was designed to store temporarily leachate at a depth greater than 30.5 centimeters, as opposed to the alternative of constructing an excessively large leachate collection tank.

The leachate collection and removal system sump is equipped with two sump pumps. One pump is a high capacity pump capable of rapid removal of large volumes of leachate, and is suitable for the transfer of batch quantities of leachate, and can handle the larger volumes of leachate anticipated from the 25-year, 24-hour storm event. The other pump is a low-capacity submersible pump located in the base of the sump. The sump pumps are located in a sump trough.

The sump trough was designed to contain the leachate below the intake of these pumps, within the smallest possible area, to minimize the residual leachate volume after each pumping cycle. The pumps are fabricated from stainless steel or other corrosion resistant material.

4.3.6.1.2 Leak Detection System

The base of the LDS is formed by the secondary geomembrane. The leak detection system is similar to the LCRS, except that the perforated collection pipe is not included. The perforated pipe is not be needed because high flow capacity is not required for the low leachate volumes.

The LDS drains to the LDS sump, which is located immediately below the LCRS sump. Because of the low volumes, the LDS is equipped with only one low-capacity submersible pump to meet WAC 173-303-665(8)(a).

4.3.6.1.3 Response Action Plan

In compliance with regulatory requirements, a response action plan (Appendix 4C) was prepared for the lined landfill. In accordance with EPA guidance, the action leakage rate was calculated as "the maximum design flow rate that the leak detection system can remove without the fluid head on the bottom liner exceeding 30.5 centimeters" (EPA 1992). If the action leakage rate were exceeded, DOE will do the following:

- Notify the appropriate regulatory authority in writing of the exceedence within 7 days of the determination.
- Submit a preliminary written assessment to the appropriate regulatory authority within 14 days of the determination, on the amount of liquids, likely sources of liquids, possible location, size, cause of any leaks, and short-term actions taken and planned.
- Determine to the extent practicable the location, size, and cause of any leak.
- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether the unit should be closed.
- Determine any other short-term and/or long-term actions to be taken to mitigate or stop any leaks.
- Within 30 days after the notification that the action leakage rate has been exceeded, submit to the appropriate regulatory authority the results of the analyses specified in the following paragraphs, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the leak detection system exceeds the action leakage rate, DOE will submit to the appropriate regulatory authority, a report summarizing the results of any remedial actions taken and actions planned.

The leachate will be analyzed for RCRA constituents as appropriate. A procedure will be in place to address details of analysis (i.e., analyses, constituents, test methods, etc.). If the analytical results on leakage fluids indicate that these constituents are present, and if the constituents can be traced to a particular type of waste placed in a known area of the lined landfill, it might be possible to estimate the location of the leak. In addition, waste packages might not undergo enough deterioration during the active life of the landfill to permit escape of the contents; the leachate might be clean or the composition too general to show a specific source location.

If the source location cannot be identified, large-scale removal of the waste and operations layer to find and repair the leaking area of the liner would be one option for remediation. However, this risks damaging the liner. In addition, waste would have to be handled, stored, and replaced in the landfill. Backfill would need to be removed from around any waste packages to accomplish this. If the waste packages were damaged during this process, the risk of accidental release might be high. For these reasons, large-scale removal of waste and liner system materials will not be a desirable option and will not be implemented except as a last resort.

The preferred alternative will depend on factors such as the amount of waste already in the landfill, the rate of waste receipt, the chemistry of the leachate (i.e., is it clean?), the availability of other disposal units, and similar considerations. Therefore, no single approach will be selected at this time. If necessary, an interim solution could be implemented while the evaluation and permanent remediation were performed. Examples of potential approaches include the following.

- The surface of the waste could be graded to direct run-off into a shallow pond. The surface would be covered with the low-hydraulic conductivity layer (geomembrane). Precipitation would be pumped or evaporated from the pond and would not infiltrate the waste already in the lined landfill. Waste would be placed only during periods of dry weather, and stored at other onsite TSD units at other times. This type of approach also could be used to reduce leakage immediately after the action leakage rate was exceeded, while other remediation options were evaluated.
- Partial construction of the final closure cover could begin earlier than planned. This would reduce infiltration into the lined landfill, and possibly reduce the leakage rate if the cover were constructed over the failed area.
- A layer of low-hydraulic conductivity soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second 'primary' liner higher in the lined landfill. This new liner would intercept precipitation and allow its removal.
- A rigid-frame or air-supported structure could be constructed over the landfill to ensure that no infiltration occurs. Although costly, this approach could be less expensive than constructing a new landfill.

In general, the selected remediation efforts will be progressive. Those remediation methods that are judged the least difficult and the most cost effective will be used first. If these efforts are not effective, more difficult or expensive options would be used.

4.3.6.2 Equivalent Capacity

The CDN drainage layers used will be available commercially and will have equivalent flow capacity to a 30.5-centimeters layer of granular drainage material with a hydraulic conductivity of 1×10^{-2} centimeter per second.

4.3.6.3 Grading and Drainage

In accordance with EPA guidance, all areas of the lined landfill floor (except the sump bottoms) are graded at a slope of at least 2 percent towards the centerline of each cell. The centerline of each cell has a 1 percent slope lengthwise towards the sump, to facilitate drainage and avoid ponding on the liners. Grading tolerances have been established to ensure proper slope is maintained.

4.3.6.4 Maximum Leachate Head

The maximum head on the primary liner is less than 30.5 centimeters, except for rare storm events as discussed in Section 4.3.6.1 and the LCRS sump trough. The sump was sized and designed to provide adequate surge storage to prevent leachate build up on the primary liner.

4.3.6.5 System Compatibility

The primary and secondary leachate collection and removal systems is composed of inert geologic materials (sand and gravel), high-density polyethylene, and other geosynthetic materials such as polypropylene. As described in Section 4.3.5.2, the geosynthetics were evaluated for compatibility with the expected leachate. To ensure that the geosynthetics used in the lined landfill are similar chemically to those evaluated, manufacturers will be required to submit quality control certificates and other manufacturing information on all materials.

Before a new waste constituent, not previously analyzed (based on a dangerous waste number), is allowed in the lined landfill, the waste constituent will be evaluated for compatibility with the liner (e.g., identified in 9090A test results or other appropriate testing methods, etc.). Other materials could contact the leachate, for example:

- HDPE and Polyvinyl chloride (PVC) piping will be used.
- Polyvinyl chloride and other plastics in miscellaneous uses.
- Leachate tank will use a chemically resistant flexible geomembrane liner system.

Compatibility of these materials with the expected leachate was considered in the landfill liner system design. Compatibility of these materials will be of lesser concern, because items that consist of these materials will be located entirely within the containment area. Failure of these items would not result in a dangerous waste release, and the materials would be replaced or repaired.

4.3.6.6 System Strength

Stability of drainage layer, strength of piping, and prevention of clogging are discussed in the following sections.

4.3.6.6.1 Stability of Drainage Layers

As described in Sections 4.3.3.3 and 4.3.5.3, the stability of the liners and leachate collection and removal systems on the sideslopes was evaluated as part of detailed design (Appendix 4A). To provide sufficiently high shear strengths at the interfaces between geosynthetic components, textured geomembranes and thermally bonded CDNs are used.

Bearing capacity of the drainage and sump gravels is expected to be adequate, based on typical strength values for granular materials.

The transmissivity of the drainage layers under the combined load of the waste and cover was addressed in the design and will be adequate to support leachate removal.

4.3.6.6.2 Strength of Piping

The drainpipes in the primary drainage and sump gravel and sideslope riser pipes are high-density polyethylene pipe. During detailed design, the required wall thickness of the pipe was determined according to the manufacturer's recommendations and standard analytical methods used by the piping industry (Appendix 4A). In these analyses, the ultimate load (derived from the estimated weight of the waste and cover) was used, the allowable deflections were limited to 5 percent, and conservative values for soil modulus and lateral confinement were assumed.

4.3.6.7 Prevention of Clogging

The geotextiles that separate the drainage layers from adjacent soil layers was selected based on the ability of the geotextiles to retain the soil and to prevent the soil from entering the leachate collection and removal systems. In addition, the amount of fine material in the drainage and sump gravels was limited by specification to less than a few percent, and is not expected to cause clogging problems (Appendix 4A). Because the waste disposed in the lined landfill will be required to satisfy LDR (RCW 70.105.050(2), WAC 173-303-140, and 40 CFR 268), the amount of organic material is minimal, and consequently biologic clogging will not be a problem.

4.3.7 Liner System, Construction and Maintenance

Details relating to the liner system construction and maintenance are discussed in the following sections.

4.3.7.1 Material Specifications

Material specifications are provided in the following sections for each of the materials used in the liner system.

4.3.7.1.1 Synthetic Liners

As described in Section 4.3.3.1, both the primary and secondary geomembrane liners consist of high-density polyethylene. As described in Section 4.3.3.1.4, the primary barrier also contains a geosynthetic clay liner placed on the floor area only. Detailed specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.2 Soil Liners

As described in Section 4.3.3.1, the soil liner consists of imported bentonite (expansive clay) blended with fine soil deposits on or next to the IDF. The fine soil was free of roots, woody vegetation, rocks greater than 2.54 centimeter in diameter, and other deleterious material. The bentonite content is dependent on the characteristics of the fine soil. Mixing was performed under carefully controlled conditions in a pugmill or other approved alternatives. The admix was placed and compacted to achieve an in-place hydraulic conductivity of 1×10^{-7} centimeter per second or less. The final surface of the soil liner was rolled smooth before placing the overlying geomembrane. Additional specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.3 Leachate Collection and Removal System

Drainage and sump gravel consisted of hard, durable, rounded to subrounded material. The gravel was washed and the amount of fine material (i.e., passing the number 200 sieve) was limited to a few percent. The hydraulic conductivity of the gravel is 1×10^{-2} centimeter per second or greater. Additional specifications were prepared as part of the design process.

For geotextiles and geonets, the composition, thickness, transmissivity, unit weight, apparent opening size, strength, and other properties were determined during detailed design based on results of engineering analyses, experience, and industry standard approaches.

4.3.7.2 Construction Specifications

Construction requirements for major components of the lined landfill are summarized in the following sections.

4.3.7.2.1 Liner System Foundation

The excavated subgrade surfaces was moisture conditioned and compacted as required to achieve the specified compaction before placing the admix layer.

4.3.7.2.2 Soil Liners

The soil and bentonite was blended thoroughly and moisture conditioned so that the admix is uniform and homogeneous throughout. The admix layer was placed in loose lifts and compacted so that the compacted lift meets the requirements of the Construction Quality Assurance Plan. Each new lift of admix was kneaded into the previously placed lift. The methods for admix preparation, type of compaction equipment, number of passes, and other details of the placement process was determined by constructing a test fill section before placing admix in the lined landfill.

4.3.7.2.3 Synthetic Liners

To protect the overlying geomembranes, the admix surface is smooth and free of deleterious material. In all cases, the high-density polyethylene liner was deployed with the length of the roll parallel to the slope. Adjacent panels were overlapped and thermally seamed using fusion or extrusion methods. Seams were inspected continuously using air pressure tests. A vacuum box was used in areas where air pressure tests cannot be used (e.g., extrusion weld areas). Destructive seam tests (ASTM D4437) (peel and adhesion) were performed on samples taken at regular intervals. Placing the overlying geosynthetic layers when practicable will protect the geomembranes.

4.3.7.2.4 Leachate Collection and Removal Systems

Drainage and sump gravel was placed and spread carefully over the underlying geosynthetics using suitable equipment to prevent damage. Hauling and placing equipment will operate on a minimum thickness of soil above any geosynthetic layer to avoid damage. Geosynthetic layers in the leachate collection and removal system were deployed, overlapped, and joined (e.g., tying for geonets, sewing for geotextiles) according to standard industry practice and the manufacturers' recommendations. Drainage and riser pipes were installed in the landfill. Pipes were bedded carefully and the landfill was backfilled to provide adequate lateral support. Pumps and other mechanical components are installed according to manufacturers' recommendations.

4.3.7.3 Construction Quality Control Program

A construction quality assurance plan (Appendix 4B) will be used during lined landfill construction and establishes in detail the following in accordance with WAC 173-303-335:

Program must include observations, test, and measurements to ensure:

- Proper construction of all components of the liners, leachate collection and removal system.
- Conformity of all materials used in the design.

4.3.7.4 Maintenance Procedures for Leachate Collection and Removal Systems

The accessible components of the leachate collection and removal system will be maintained according to preventive maintenance methods. These methods will require periodic testing to prove that the equipment, controls, and instrumentation are functional and are calibrated properly. Testing intervals will be derived from applicable regulations and manufacturer's recommendations. All pumps and motors will be started or bumped monthly or at intervals suggested by the manufacturer, first, to demonstrate that the pumps and motors are functional and second, to move the bearing(s) so that the bearing surfaces do not seize or become distorted. Instruments will be calibrated annually or at intervals suggested by the manufacturer. When applicable, the preventive maintenance methods will include calibration instructions. The following instruments will require annual calibration:

- LCRS sump level indicator
- LDS sump level indicator

Other instrumentation inside the leachate handling and storage facilities will also require routine maintenance.

4.3.7.5 Liner Repairs during Operations

Because of the 0.9-meter-thick operations layer, damage to the liner system is not expected. If damage did occur, the operations layer could be removed laterally as far as required. Underlying geosynthetic and gravel layers will be removed until an undamaged layer is encountered. The damaged layers will be repaired and replaced from the lowest layer upwards using similar methods to those employed during construction. Most repairs to the geomembranes will be performed using a patch, which will be placed, welded, and tested by construction quality assurance personnel.

4.3.8 Run-On and Runoff Control Systems

Because of the sandy soils, small drainage area, and arid climate at the IDF, stormwater run-on and run-off will not be expected to require major engineered structures. Interceptor and drainage ditches will be adequate for run-on and run-off control. The 25-year, 24-hour precipitation event was the design storm used to size the lined landfill systems. Beyond this, surface water evaluation is highly site-specific, and appropriate analyses were performed as part of detailed design for the lined landfill.

4.3.8.1 Run-on Control System

Run-on will be controlled by drainage ditches or berms around the perimeter of the lined landfill. Any overland flow approaching the landfill will be intercepted by the ditches or berms and will be conveyed to existing drainage systems or suitable discharge points. All the drainage ditches or berms were designed to handle the peak 25-year flow from the potential drainage area. By using low channel slopes, design flow velocities in the ditches will be maintained below established limits for sand channels.

Between the landfill crest and the perimeter road, the area will be graded to provide drainage toward the perimeter road. The perimeter road will be sloped outward, at a grade of approximately 2 percent, to provide drainage away from the landfill. On the outside of the perimeter road, drainage ditches will be excavated to provide drainage away from the landfill.

4.3.8.1.1 Design and Performance

Design and performance details were determined for the landfill as part of the detailed design process.

4.3.8.1.2 Calculation of Peak Flow

Computation of design discharge for the drainage ditches or berms was performed using standard analytical methods, such as the Rational Method or the computer program HEC-1 (USACE 1981). The 25-year, 24-hour precipitation depth is 4.0 centimeters, based on precipitation data recorded from 1947 to 1969 (PNL-4622). The tributary area for each section of ditch or berm was based on local topography.

4.3.8.2 Runoff Control System

There will be no run-off from the lined landfill because the landfill will be constructed below grade. Any precipitation falling on the landfill will be removed by either evapotranspiration or the leachate collection and removal systems. Therefore, a run-off control system will not be needed.

4.3.8.3 Construction

The drainage ditches or berms around the lined landfill were constructed with conventional earthmoving equipment such as graders and small dozers.

4.3.8.4 Maintenance

The drainage ditches or berms require periodic maintenance to ensure proper performance. The most frequent maintenance activity, beyond periodic inspection, will be cleaning the ditches or berms to remove obstructions caused by windblown soil and vegetation (e.g., tumbleweeds). After rare storm events, regrading of the ditch bottom or repair of the berm might be required to repair erosion damage. This is expected to occur infrequently; however, inspections will be conducted after 25-year storm events or at least annually.

4.3.9 Control of Wind Dispersal

The IDF will use varied methods to prevent wind dispersal of mixed waste and backfill materials, depending on the waste form. Methods to prevent wind dispersal include containerizing, stabilizing, grouting, spray fixitants, and backfill. In other instances, the operating contractor implements a wind speed restriction during handling, and immediately backfills the waste to prevent wind dispersal.

4.3.10 Liquids in Landfills

Free liquids will not be accepted except as allowed by Chapter 3.0, Section 1.2. Waste received at the IDF must comply with waste acceptance requirements.

4.3.11 Containerized Waste

Containerized waste received in the IDF lined landfill will be limited to a maximum of 10 percent void space. Several inert materials (diatomaceous earth, sand, lava rock) will be used as acceptable void space fillers for waste that does not fill the container.

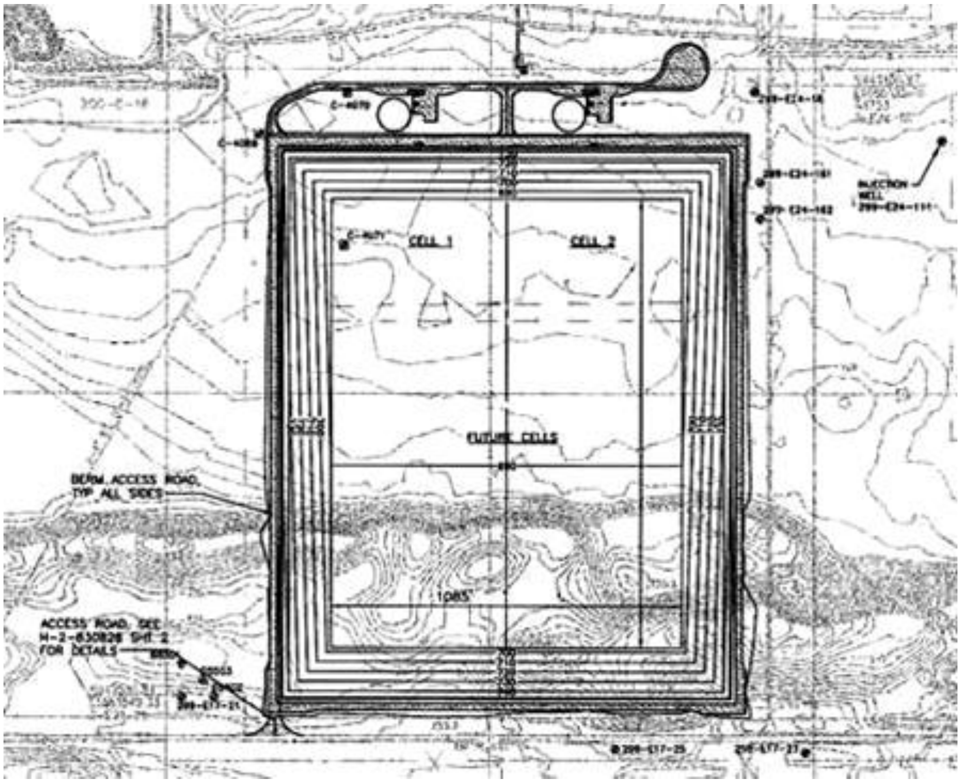
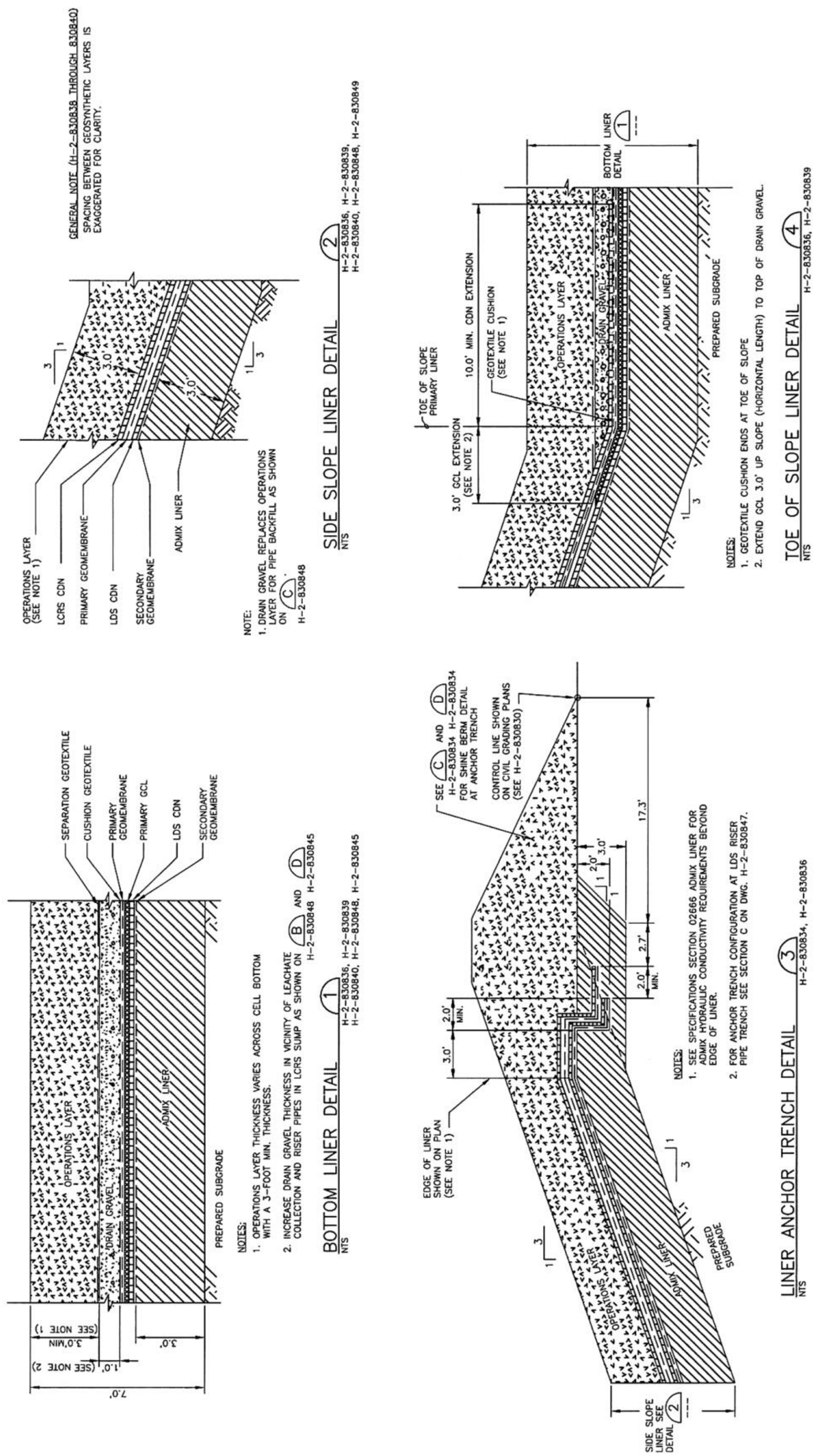


Figure 4.1. Integrated Disposal Facility Lined Landfill



1 **Figure 4.2. Example of a Typical Liner**

INTEGRATED DISPOSAL FACILITY
APPENDIX 4A – SECTION 1
PHASE I CRITICAL SYSTEMS DESIGN REPORT

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
08/25/2016	8c.2016.Q2

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APPENDIX 4A – SECTION 1
PHASE I CRITICAL SYSTEMS DESIGN REPORT

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APPENDIX 4A – SECTION 1
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ACRONYMS AND ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
Affiliate	CH2M HILL, Inc.
AFI	Air freeze index
ALR	Action leakage rate
AOS	Apparent opening size
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
bgs	Below ground surface
CDN	Composite drainage net
CDR	Conceptual Design Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH2M HILL	CH2M HILL Hanford Group, Inc.
Design Report	IDF Phase I Critical Systems Design Report
DOE	U.S. Department of Energy
DBVS	Demonstration Bulk Vitrification System
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FH	Fluor Hanford, Inc.
FLA	Full load amperage
FS	Factor of safety
FVNR	Full Voltage Non-Reversing
GCL	Geosynthetic clay liner
GFCI	Ground fault circuit interrupters
gpm	Gallons per minute
GRI	Geosynthetic Research Institute
HDPE	High-density polyethylene
HEC	Hydraulic Engineering Circular-1
HELP	Hydrologic Evaluation of Landfill Performance (Model)
HF	Hanford Facility
HMS	Hanford Meteorological Station
HVAC	Heating, ventilating, and air conditioning
I/O	Input/output
ICDF	INEEL CERCLA Disposal Facility (Idaho Falls, ID)

IDF	Integrated Disposal Facility (Hanford)
IEEE	Institute of Electrical and Electronic Engineers
IES	Integrated Engineering Software, Inc.
ILAW	Immobilized low-activity waste
INEEL	Idaho National Environmental Engineering Laboratory
LAN	Local area network
LCRS	Leachate collection and removal system
LDS	Leak detection system
LERF	Liquid Effluent Retention Facility (Hanford)
LLW	Low-level waste
MBPS	Megabits per second
MCC	Motor control center
MLLW	Mixed low-level wastes
NEC	National Electrical Code
NFPA	National Fire Protection Association
OIU	Operator interface unit
ORP	Office of River Protection
PC	Performance category
PICS	Process Instrumentation and Control Systems
PLCs	Programmable logic controllers
PNNL	Pacific Northwest National Laboratory
psi	Pounds per square inch
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
RAP	Response Action Plan
RCRA	Resource Conservation and Recovery Act of 1976
RF	Radio frequency
RGS	Rigid galvanized steel
RPP	River Protection Project
SCADA	Supervisory control and data acquisition
SDR	Standard dimension ratio
SOW	Statement of work
SPT	Standard Penetration Testing
SSCs	Systems, structures, and components
STI	Soil Technology, Inc. (Bainbridge Island, Washington)

THW	Thermoplastic, vinyl insulated building wire; flame retardant, moisture and heat resistant, 75°C, dry and wet locations
TSD	Treatment Storage and Disposal facility
TRU	Transuranic waste (concentrations of transuranic radionuclides greater than or equal to 100nCi/g of the waste matrix)
UBC	Uniform Building Code
UPS	Uninterrupted power supply
USCS	Unified Soil Classification System
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation
WTP	Waste Treatment and Immobilization Plant (Hanford)

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1.0 INTRODUCTION

1.1 Purpose

The purpose of the Integrated Disposal Facility (IDF) is to develop the capability for near surface disposal of Immobilized Low-Activity Waste (ILAW) waste packages from the River Protection Project–Waste Treatment and Immobilization Plant (RPP-WTP). The IDF is essential in meeting the overall U.S. Department of Energy, Office of River Protection (ORP) mission to store, retrieve, treat, and dispose of the highly radioactive Hanford tank waste in an environmentally sound, safe, and cost-effective manner. The IDF will also provide capacity for disposal of mixed low-level waste (MLLW) and low-level (LLW) from the DBVS. The detailed design for the IDF Phase I Critical Systems landfill will finalize the design process for the:

- Landfill liner system
- Leachate removal system
- Leak detection system (LDS)

The IDF detailed design also involves completing all design work required for an operable landfill and supporting the Resource Conservation and Recovery Act of 1976 (RCRA) Part B permitting for the IDF.

This Phase I Critical Systems Design Report (the Design Report) provides documentation of engineering calculations, criteria, and information that have been developed as part of the IDF detailed design for Phase I. Specifically, the Design Report documents the following important design information:

- Identifies key design requirements for the project (Section 2).
- Summarizes studies on site conditions and investigations that have been used in the development of detailed design parameters for the critical systems (Sections 3 and 4).
- Presents detailed engineering analysis performed in the development of the Phase I Critical Systems design and updated during construction implementation (Section 5).
- Provides system component descriptions, references important construction quality assurance (QA) requirements, and describes important interfaces with non-critical systems (Section 6).
- Describes operating provisions that have influenced the development of the design including waste placement requirements, operational interfaces with other Hanford facilities, and leakage response action plan requirements (Section 7).

Design information pertaining to modifications to critical systems performed during IDF infrastructure construction are included in this design report. These modifications are described in CHPRC-03958, *Final Design Report for the Integrated Disposal Facility Infrastructure*, Section 4.5, and includes the following:

- Removal of geomembrane floating cover, and replacement with a fabricated aluminum dome cover.
- A leachate transfer pipeline connected through the two leachate transfer buildings to allow flexibility with leachate management between the storage tanks and disposal cell sumps.

1.2 Scope

1.2.1 General

CH2M HILL, Inc. (Affiliate) is responsible for production of a cost-effective final design and to produce critical systems detailed design documents and construction specifications to facilitate RCRA permit approval of the IDF. The IDF technical requirements are found in the following documents:

- Immobilized Low-Activity Waste (ILAW) Project Definition Criteria, Revision 1 (RPP-7898)
- System Specifications for ILAW Disposal, Revision 3 (RPP-7307)

- Hanford Environmental Management Specification (DOE/RL-97-55)

Design products are to be prepared in compliance with the technical requirements, as well as with other specific procedures that are dictated by CH2M HILL Hanford Group, Inc. (CH2M HILL) requirements and outlined in the Statement of Work (SOW), *Integrated Disposal Facility Detailed Design Support* (Rev. 2, 2003), described in more detail under Section 2 of this Design Report. The overall design work includes reports, schedules, estimates, and other special services as specified in the SOW. As part of the design effort, the Affiliate will perform the following global tasks:

- Develop a conceptual layout and preliminary design drawings for the IDF. The IDF preliminary layout will depict a single expandable landfill system, with capability for segregation of RCRA regulated and non-regulated waste placement and segregated leachate management systems.
- Develop a detailed design that meets the requirements of the ILAW Project Definition Criteria and the ILAW System Specification.
- Develop the construction specifications for the detailed design.
- Ensure that there is full technical integration between all detailed design reports prepared for the detailed design of the IDF.
- Perform the design activities in accordance with all applicable regulatory requirements.

The design will implement the safety and health protection requirements imposed on the design by the SOW and the technical baseline criteria documents, and will comply with all applicable regulatory requirements for the project. It is important to note that although the design is for identified critical systems of the Phase I IDF, a preliminary safety evaluation was performed for the W-520 Project that identified no safety class items, including criticality safety (*Conceptual Design Report for ILAW Facility*, CH2M HILL, May 2001).

The timely completion of the critical system detail design of the IDF, in compliance with the RCRA permit approval process (Washington Administrative Code [WAC] 173-303-665 and 173-303-806[4][h]), is a critical component of the SOW. Drawings, construction specifications, and reports needed to obtain U.S. Department of Energy (DOE) certification and Washington State Department of Ecology (Ecology) approval of the IDF RCRA Part B permit is the overall goal of the project. The detailed design for the initial Phase I disposal landfill and the critical systems design include the liner system, the leachate collection system, and the LDS. The detailed design will produce an operable landfill design and support the IDF RCRA Part B permitting.

1.2.2 Design Report

The Design Report describes the key facility components and provides the design basis and detailed calculations that support the development of drawings and specifications. Key facility components that are described in the Design Report include:

- Facility layout (location, access roads and operational ramps, survey control system).
- Landfill geometry (disposal volume total and per disposal unit, disposal unit dimensions).
- Disposal unit grading design (foundation soils contour, lower admixture layer contour, operations layer cover contour).
- Grid point listing (grid point number, location, and elevation for all grid points required for construction of the IDF).
- Geosynthetic material design (primary geomembrane, secondary geomembrane, geotextile, and geocomposite drainage layer).
- Leachate collection and removal system (LCRS) and LDS design (sump design, removal system design–LCRS and LDS, leachate level monitoring system design, transfer pump as required to meet WAC-173-303-665(2)(h)(ii) to ensure that the leachate depth over the liner does not exceed 12 inches).

- Leachate temporary storage tank system design (tank volume, tank design, tank materials/ leachate compatibility, tank coating, tank secondary containment system, leachate transfer pipe lines), including electrical and power requirements necessary to support the leachate removal systems.
- Pump controls and instrumentation design (control, operations, monitoring, and control building design).
- Operational storm water management design.
- Backfill placement requirements and process (minimize void space, minimize subsidence of waste, placement and material requirements to ensure there are no adverse effects on the waste packages).
- Other facility designs identified as necessary to support the project completion.

The Design Report includes design calculations that are prepared in accordance with the requirements of procedure HNF-IP-0842 Vol. 4, Section 3.6 (July 30, 2002). Important calculations that are documented include:

Stability (liner side slope [each liner layer based on interface strength], requirements for verification for critical interface strengths, fill placement ramp, global stability of the overall design, and other relevant stability analysis).

Seismic analysis (side slope and global embankment stability under seismic loading, and seismic design of structures)

Bearing capacity (liner sub-grade soils and other relevant bearing capacity analysis)

Total settlement, differential settlement, and uplift analysis (foundations soils, compacted admixture layers, total settlement, top slope drainage evaluation, subsidence and sinkhole potential, uplift potential, and other relevant settlement analysis).

Admix liner analysis (liner admixture bearing capacity, admix liner specifications, desiccation cracking, and other relevant liner admixture analysis).

Geomembrane liner analysis (liner tension caused by thermal contraction/ expansion, anchor trench pullout analysis, puncture resistance, potential stress cracking, leachate compatibility, chemical and radiation resistance, mechanical degradation from operational traffic, and other relevant geomembrane analysis).

Drainage layers analysis (geotextile analysis and selection, geocomposite selection, drainage gravel selection analysis, and other relevant drainage analysis).

LCRS/LDS analysis (clogging prevention in LCRS, design of leachate collection sumps, design of high capacity and low capacity leachate removal pumping systems, design of leachate storage tank and secondary containment system, leachate depth monitoring system, design of leachate system control building, leachate compatibility of components in the LCRS, and other relevant leachate analysis).

Leachate system earth loading analysis (LCRS and LDS slope riser pipes, LCRS collection pipe, leachate transfer pipes, and other relevant system loading analysis).

Surface stormwater analysis (operations in-cell stormwater management, operations runon/runoff water management, site stormwater collection/evaporation management system, and other relevant storm water analysis).

Leachate production analysis (average annual leachate production, peak daily leachate production, leachate tank storage capacity, leachate transportation truck capacity, and trip frequency)

Action leakage rate (ALR) analysis (the maximum design flow rate that the secondary leachate collection, detection, and removal system can remove without the fluid head on the bottom liner exceeding one foot;

calculation and justification of the maximum leachate infiltration rate through the primary liner system; a response action plan in case the maximum ALR is exceeded during operation of the IDF).

Updates to calculations that have occurred through the construction process, either during independent quality reviews of tank systems, in response to contractor's requests for information, or changes implemented during construction have been attached to the original calculations in the appendices.

Compliance matrices have been developed to demonstrate detailed design compliance with the applicable sections of the regulations (WAC 173-303) and with project-specific specifications, criteria, reports, codes, and standards.

Updates to the matrices that have resulted from the completion of construction activities and associated documentation are also provided. These matrices are presented in the Design Report in Appendix A.

1.3 Authorization

After careful consideration and evaluation, CH2M HILL elected to self-perform the IDF Phase I Critical Systems design. As such, the design is being performed as an inter-company work assignment by the Affiliate under the direction of CH2M HILL. CH2M HILL was authorized to self-perform the work by the U.S. Department of Energy, Office of River Protection (ORP), in a letter dated December 9, 2002.

CH2M HILL's Prime Contract Number with the ORP is DE-AC06-99RL14047. The inter-company work assignment is Contract 12317, Release 22, dated November 7, 2002.

1.4 General Facility Description

The IDF will consist of an expandable lined landfill located in the 200 East area on the Hanford Facility (HF). The landfill will be divided lengthwise into two distinct cells, one for disposal of low-level waste (LLW) and the other for disposal of mixed waste. The mission of the IDF will include the following functions:

- Provide an approved disposal facility for the permanent, environmentally safe disposition of ILAW packages that meets the environmental requirements and is approved by the DOE and Ecology.
- Receive ILAW from River Protection Project (RPP) tank operations and dispose this waste onsite. Receive waste from the DBVS and dispose this waste onsite.
- A more detailed discussion of waste types and the necessary storage volumes for these wastes is provided in Sections 5 and 6, respectively.
- The IDF will be constructed on 25 hectares of vacant land southwest of the Plutonium Uranium Extraction Facility (PUREX) Plant in the 200 East Area. The IDF will consist of a lined landfill that will be constructed in several phases. The landfill will be segregated into a RCRA permitted cell and a non-RCRA permitted cell. The scope of this permit is limited to the western cell of the landfill where the RCRA waste will be stored and disposed. The landfill is designed to accommodate four layers of vitrified LAW waste containers separated vertically by 0.9-meters of soil.
- This initial construction will start at the northern edge and the size is approximately 223 meters East/West by 233 meters North/South by 14 meters deep. At this initial size, IDF disposal capacity is 82,000 cubic meters of waste. Subsequent construction phase(s) will require a modification to the Part B Permit to be constructed after waste placement has progressed in the landfill to the point that additional disposal capacity is needed. This approach minimizes the open area susceptible to collection of rainwater and subsequent leachate
- The landfill is currently estimated at full build out to be up to 446 meters wide by 555 meters in length by up to 14 meters deep. The RCRA regulated portion of the landfill would be half of that at approximately 223 meters wide by 555 meters long by up to 14 meters deep providing a waste disposal capacity of up to 450,000 cubic meters.

- Both cells will have a RCRA C-compliant liner system that consists of an upper primary liner overlying a lower secondary liner. The upper liner will consist of a composite geomembrane liner and geosynthetic clay liner system on the bottom area, and a single geomembrane on the side slope. The secondary liner will consist of a composite geomembrane, overlying a 3-foot-thick soil admix liner. A LCRS and a LDS will overly the primary and secondary liner system, respectively. A Secondary Leak Detection System (SLDS) will be located below the clay liner, beneath the LDS sump.
- The IDF also will include a less than 90-day accumulation area of leachate for storage in two tanks, one per landfill ~~half~~cell. The leachate storage tanks will be located at the north end, in close proximity to the lined landfill. Each tank will be protected by secondary containment (double-lined tanks). Leak detection will be provided by monitoring of the secondary containment. The collected leachate will be stored and sampled before transfer to an onsite Treatment Storage and Disposal (TSD) unit or offsite TSD facility. The less than 90-day storage leachate collection tanks will be operated in accordance with the generator provisions of WAC 173-303-200 and WAC 173-303-640, as referenced by WAC 173-303-200. The overall ~~side~~ site development plan is shown in Figure 1-2.
- The landfill will be constructed in several phases. Starting at the northern edge, approximately one-third of the total length of the landfill will be constructed in Phase I. This will include the leachate collection system and 90-day accumulation tanks. The subsequent phases will be constructed after waste has been placed in the landfill and additional disposal capacity is needed. This approach will minimize the amount of open area susceptible to collection of rainwater and subsequent leachate.
- Before disposal, all waste will meet land disposal restriction requirements [Revised Code of Washington 70.105.050(2), WAC 173-303-140, and 40 Code of Federal Regulations (CFR) 268, incorporated by reference in WAC 173-303-140].
- Future landfill development and configuration within the IDF will be subject to change as disposal techniques improve or as waste management needs dictate. Additional IDF landfill development beyond the 62 acres will be subject to an approved permit modification, in accordance with the HF RCRA Permit (Ecology, 2001).
- Public access to the IDF will be restricted. Trucks typically will be used to transport waste to the IDF and will range in size from heavy-duty pickups to tractor-trailer rigs, depending on the size and weight of the load. In some cases, special equipment (such as transporters) will be used for unusual or unique loads. When special equipment is used, a prior evaluation will ensure that the equipment does not damage the roadways.
- Approximately 60 personnel will traverse this roadway daily in three shifts via personal vehicles per week

Figure 1-1. Integrated Disposal Facility Site Plan

Located in Chapter 1.0, Part A Form

Figure 1-2. Overall Site Development Plan/Transportation Routes

Located in Chapter 4.0, Figure 4.1

2.0 DESIGN REQUIREMENTS

Minimum design requirements for the IDF Phase I Critical Systems Design were provided by CH2M HILL in the SOW for Requisition # 92859, Integrated Disposal Facility Detailed Design Support, Revision 2, February 18, 2003. The IDF Phase I Critical Systems Design has been performed in compliance with all applicable design requirements, defined in Sections 2.1 through 2.7, and these requirements are:

- *Washington State Dangerous Waste Regulations* (WAC 173-303)
- *System Specification for Immobilized Low-Activity Waste Disposal System,* Revision 3 (RPP-7307)
- *ILAW Project Definition Criteria for Integrated Disposal Facility,* Revision 1 (RPP-7898)
- *Hanford Site Environmental Management Specification,* Revision 2 (DOE/RL-97-55)
- *Design Loads for Tank Farm Facilities* (TFC-ENG-STD-06, REV A)
- Technical baseline documents listed in Section 3.1 of the SOW
- Applicable national codes and standards

2.1 Washington State Dangerous Waste Regulations

The *Washington State Dangerous Waste Regulations* (WAC 173-303) implement Subtitle C of Public Law 94-580, the RCRA in the State of Washington. By conforming to the requirements of WAC 173-303, the design of the IDF Phase I Critical Systems also complies with the federal hazardous waste requirements contained in 40 CFR 264, *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*. Appendix A.1 provides a compliance matrix of where the applicable WAC 173-303 requirements are addressed in the IDF Phase I Critical Systems detailed design documents, or are addressed in documentation developed as a result of facility construction.

2.2 System Specification

The *System Specification for Immobilized Low-Activity Waste Disposal System,* Revision 3 (RPP-7307) contains the Level 1 system requirements for the Immobilized Low-Activity Waste Disposal System, of which the IDF is a part. Appendix A.2 provides a compliance matrix of where the applicable Level 1 system requirements are addressed in the IDF Phase I Critical Systems detailed design documents, or are addressed in documentation developed as a result of facility construction.

2.3 Project Definition Criteria

The *ILAW Project Definition Criteria for Integrated Disposal Facility*, Revision 1 (RPP-7898) contains the design criteria for the IDF, including requirements flow-down from RPP-7303, *System Specification for ILAW Disposal System*, and DOE/RL-97-55, *Hanford Site Environmental Management Specification*. Appendix A.3 provides a compliance matrix of where the applicable design criteria are addressed in the IDF Phase I Critical Systems detailed design documents, or are addressed in documentation developed as a result of facility construction.

2.4 Hanford Site Environmental Management Specification

The *Hanford Site Environmental Management Specification* (site specification), Revision 2 (DOE/RL-97-55) documents the top-level mission technical requirements for work involved in the Richland Operations Office, Hanford Site cleanup and infrastructure activities, under the responsibility of the DOE Office of Environmental Management. It also provides the basis for all contract technical requirements. Section 3.3.2, 200 Area Materials and Waste Management of the site specification contains the requirements for receiving and onsite disposal of ILAW from RPP tank operations. The documents, orders, and laws referenced in the site specification represent only the most salient sources of requirements. As such, the site specification is assumed to have no significant measurable requirements that would directly affect the IDF Phase I Critical Systems design.

2.5 Design Loads for Tank Farm Facilities

The *Design Loads for Tank Farm Facilities* (TFC-ENG-STD-06, REV A) defines the design requirements for systems, structures, and components (SSCs), and provides the minimum criteria for structural design and evaluation of SSCs. The standard establishes structural design loads and acceptance criteria for use in designing new SSCs. Figure 1 of this standard indicates that for new SSCs, structures and anchorage of systems and components are to be designed per DOE-STD-1020-02 and Section 3.0 of this standard. These were used for the design of the IDF Critical Systems facilities. The IDF Critical Systems facilities were defined by CH2M HILL as being Performance Category (PC)-1. The PC-1 requirements in this standard were used in the structural design of the facilities included in IDF Phase I Critical Systems.

2.6 Technical Baseline Documents

The technical baseline documents are listed in Section 3.1 of the SOW. These documents include the System Specification for Immobilized Low-Activity Waste Disposal System, ILAW Project Definition Criteria for Integrated Disposal Facility, Hanford Site Environmental Management Specification, and Design Loads for Tank Farm Facilities, discussed in the preceding sections.

2.7 National Codes and Standards

In addition to WAC 173-303, the system specification, project definition criteria, site specification, and tank farm design loads that are discussed above, the IDF Phase I Critical Systems design was guided by other applicable sections of accepted professional and industry standards. These included the following:

- Air Moving and Conditioning Association
- American Association of State Highway and Transportation Officials (AASHTO)
- American Concrete Institute
- American Galvanizers Association
- American Institute of Steel Construction
- American Iron and Steel Institute
- American National Standards Institute
- American Society for Testing and Materials (ASTM)
- American Society of Civil Engineers (ASCE)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers
- American Society of Mechanical Engineers
- American Water Works Association (AWWA)
- American Welding Society
- Building Officials and Code Administrators – Basic Building Code
- Code of Federal Regulations (CFR)
- Concrete Reinforcing Steel Institute (CRSI)
- Federal Standards
- Geosynthetic Research Institute (GRI)
- Hydraulic Institute Standards
- Institute of Electrical and Electronic Engineers (IEEE)
- International Conference of Building Officials – Uniform Building Code (UBC)
- Manufacturers Standardization Society
- Metal Building Manufacturers Association
- National Electrical Code (NEC)
- National Electrical Manufacturers Association

- National Fire Protection Association (NFPA)
- National Institute of Standards and Technology
- Occupational Safety and Health Administration
- Sheet Metal and Air Conditioning Contractors National Association
- Steel Door Institute
- Steel Structures Painting Council
- Specialty Steel Institute of North America
- The Aluminum Association, Inc.
- Underwriters Laboratories, Inc.
- Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge and Municipal Construction

3.0 SITE CONDITIONS

This section presents information on the Hanford Site and the area on the site where the IDF will be located. This information was obtained primarily from the *ILAW Preliminary Closure Plan for the Disposal Facility* (RPP-6911) and other Hanford Site data sources. It is intended to provide a general characterization of the IDF site conditions that are pertinent to the design of the IDF Phase I Critical Systems.

3.1 Geography

The following paragraphs briefly describe the geography of the IDF site and are prepared from information in the *ILAW Preliminary Closure Plan for the Disposal Facility* (RPP-6911).

3.1.1 Site Location

The location of the IDF is on the Hanford Central Plateau, in the 200 East Area within the Hanford Site boundary. The site identified for the IDF is 68 hectares (168 acres) of vacant and uncontaminated land, located southwest of the PUREX plant in the 200 East Area. It is bounded on the south by 1st Street and on the north by 4th Street.

3.1.2 Site Description

The IDF landfill will occupy approximately 25 hectares (62 acres) of the site identified for the facility. The remainder of the site will be used for soil stockpile, leachate storage tanks, operations support facilities, roads, parking areas, and open space. The IDF in Phase I will be approximately 11 hectares (28 acres). Phase I will be located at the north end of the IDF landfill and will include provisions for expansion to the south for future phases.

3.2 Meteorology and Climatology

The following paragraphs briefly describe the climate of the IDF site and are prepared from information in the *ILAW Preliminary Closure Plan for the Disposal Facility* (RPP-6911), which presented summary data from the Hanford Meteorological Station (HMS). Conditions at the HMS are considered similar to those at the IDF site. Detailed information is available in the *Hanford Site Climatological Data Summary 2001, with Historical Data* (Pacific Northwest National Laboratory, May 2002). The IDF Phase I Critical Systems is designed to operate in the climatic conditions reported in that document.

3.2.1 Precipitation

The site sits within the Pasco Basin, characterized as a semi-arid region because of its low annual precipitation levels. The basin receives 16 cm (6.3 inches) of annual average precipitation, with nearly half occurring in the winter months. Historical records indicate that the annual precipitation has varied from a low of 8 cm (3.1 inches) to a high of 30 cm (11.8 inches). Precipitation of 4 cm (1.56 inches) in 24 hours reportedly can be expected to occur once every 25 years.

However, based on the *Hanford Site Climatological Data Summary 2001*, a value of 1.28 inches was used for the 24-hour, 25-year precipitation in the IDF Phase I Critical Systems stormwater design analysis (see Appendix C.9). Total annual snowfall has varied from 0.8 cm to 110 cm (0.31 to 43.3 inches), with an average annual snowfall of 34 cm (24.4 inches).

3.2.2 Temperature

Temperature conditions for the site range from extremely cold during the winter months to extremely warm during the summer months. Local temperatures can reach -18 degrees C (0 degrees F) during some winter months. January is the coldest month, with an average temperature of -2 degrees C (29 degrees F). The lowest temperature ever recorded was -33 degrees C (-27 degrees F). During some summer months, daytime temperatures can exceed 40 degrees C (104 degrees F). July is the warmest month, with daily high and low temperatures averaging 33 and 25 degrees C (92 and 61 degrees F), respectively. The highest temperature ever recorded was 46 degrees C (115 degrees F).

3.2.3 Wind

Wind conditions can vary considerably throughout the year. The monthly average is about 10 kilometers/hour (6 miles/hour) during the winter and 15 kilometers/hour (9 miles/hour) during the summer. Wind speeds, especially during summer storm activity, can reach many times the average levels. The greatest peak gust was 130 kilometers/hour (81 miles/hour), recorded at 15 meters (50 feet) above the ground at the HMS.

3.2.4 Relative Humidity

The seasonal variation in the relative humidity is considerable, according to records of the HMS. The annual mean relative humidity recorded at HMS is approximately 54 percent, with the highest monthly average relative humidity (80 percent) occurring in December and the lowest monthly average relative humidity (32 percent) occurring in July. Daily relative humidity can change 20 to 30 percent between early morning and late afternoon, except in the winter months when changes are less pronounced.

3.3 Ecology

The following paragraphs briefly describe the ecology of the Hanford Site and are prepared from information in the *ILAW Preliminary Closure Plan for the Disposal Facility* (RPP-6911). The site consists of undeveloped land and is characterized as a shrub-steppe environment. This environment contains numerous plants and animal species, adapted to the regions semi-arid climate. Because of the aridity and low water-holding capacity of the soils, the productivity of both plants and animals is relatively low. The IDF site exhibits many of these same general characteristics, although to varying degrees.

3.3.1 Flora

The dominant plants on the Hanford Site are big sagebrush, rabbitbrush, cheatgrass, Russian thistle, and Sandberg's bluegrass, with cheatgrass providing half of the plant cover. Root penetration to depths of over 3 m has not been demonstrated in the 200 Areas. Rabbitbrush roots have been found only at a depth of 2.4 m (8 feet) near the 200 Areas.

3.3.2 Fauna

A variety of birds and mammals inhabit the Hanford Site. The most abundant nesting birds of the shrub-steppe at the site are the horned lark and western meadowlark. Significant populations of chukar and grey partridge inhabit the Hanford Site. The most abundant mammals at the site are mice, ground squirrels, gophers, voles, and cottontail rabbits. Larger animals include mule deer and elk. The coyote is the principal mammalian predator on the Hanford Site.

3.4 Geology

3.4.1 Regional Geology

The 200 East Area lies on the Cold Creek bar, a geomorphic remnant of the cataclysmic, glacial related floods of the Pleistocene Epoch. As the floodwaters raced across the lowlands of the Pasco Basin and Hanford Site, floodwaters lost energy and began to deposit sand and gravel. The 200 Area Plateau is one of the most prominent deposits. The 200 Area Plateau lies just southwest of one of the major flood channels across the Hanford Site that forms the topographic lowland south of Gable Mountain.

Borehole data provide the principal source of geologic, hydrologic, and groundwater information for the 200 East Area and the IDF site. Numerous boreholes (both vadose zone boreholes and groundwater monitoring wells) have been drilled in the 200 East Area for groundwater monitoring and waste management studies (Figure 3-1 shows the location of groundwater wells near the IDF site). However, data are limited within the IDF site, primarily because no previous construction or waste disposal activities have occurred in this part of the HF. Most boreholes in the 200 East area have been drilled using the cable tool method and either a hard tool or drive barrel to advance the hole. Some boreholes have been drilled by rotary and wire-line coring methods. More recently, boreholes in the area have been drilled, and in five cases cored, by percussion hammer methods. Geologic logs are based on examination of drill core, chips, and cuttings from these boreholes. Chip samples typically are taken at 1.5-meter (4.92 feet) intervals and routinely archived at the Hanford Geotechnical Sample Library.

3.4.2 Site Geology

The IDF site will be located south of the Gable Mountain segment of the Umtanum Ridge anticline and about 3 kilometers (1.86 miles) north of the axis of the Cold Creek syncline, that controls the structural grain of the basalt bedrock and the Ringold Formation. The basalt surface and Ringold Formation trend roughly southeast-northwest parallel to the major geologic structures of the site. As a result, the Ringold Formation and the underlying Columbia River Basalt Group gently dip to the south off the Umtanum Ridge anticline into the Cold Creek syncline.

Geologic mapping on the Hanford Site and examination of drill core and borehole cuttings in the area have not identified any faults in the vicinity of the IDF site (DOE/RW-0164). The closest known faults are along the Umtanum Ridge-Gable Mountain structure, north of the disposal site and the May Junction Fault east of the site (Figure 3-2).

3.4.2.1 Stratigraphy

The basalt and post-basalt stratigraphy for the IDF site is shown in Figure 3-3. Approximately 137 to 167 meters (449 to 548 feet) of suprabasalt sediments overlie the basalt bedrock at the site.

Basalt Bedrock. Previous studies (RHO-BWI-ST-14; Reidel and Fecht, 1994) have shown that the youngest lava flows of the Columbia River Basalt Group at the 200 East Area are those of the 10.5 million-year old Elephant Mountain Member. This member underlies the entire 200 East area and surrounding area, and forms the base of the suprabasalt aquifer. No erosional windows in the basalt are known or suspected to occur in the area of the IDF site.

Ringold Formation. Few boreholes penetrate the entire Ringold Formation at the IDF site, so available data are limited. The Ringold Formation reaches a maximum thickness of 95 meters (312 feet) on the west side of the site and thins eastward. The member of Wooded Island (Figure 3-3) is the only member of the Ringold Formation in the 200 East Area. The deepest Ringold Formation unit encountered is the lower gravel, unit A. Lying above unit A is the lower mud, and overlying the lower mud is an upper gravel, unit E. The sand and silt units of the members of Taylor Flat and Savage Island of the Ringold Formation are not present at the IDF site. Unit A and unit E are equivalent to the Pliocene-Miocene continental conglomerates (Reidel and Fecht, 1994). The lower mud is equivalent to the Pliocene-Miocene continental sand, silt, and clay beds (Reidel and Fecht, 1994).

Only three boreholes have penetrated unit A in the area of the IDF site. Unit A is 19 meters (62 feet) thick on the west side of the site and thins to the northeast. Unit A is partly to well-cemented conglomerate consisting of both felsic and basaltic clasts in a sandy matrix and is interpreted as fluvial gravel facies (Lindsey, 1996). There are minor beds of yellow to white interbedded sand and silt. Green-colored, reduced-iron stain is present on some grains and pebbles. Although the entire unit appears to be cemented, the zone produced abundant high-quality water in borehole 299-E17-21 (PNNL-11957, 1998).

Nineteen meters (62 feet) of the lower mud unit were encountered in one borehole at the IDF site (PNNL-11957, 1998). The uppermost one-meter or so consists of a yellow mud to sandy mud. The yellow mud grades downward into about 10 meters (33 feet) of blue mud. The blue mud, in turn, grades down into seven meters (23 feet) of brown mud with organic rich zones and occasional wood fragments. The lower mud unit is absent in the center of the site (northeast of borehole 299-E24-7 on Figure 3-4).

Unit E is described as a sandy gravel to gravelly sand. Unit E is interpreted to consist of as much as 15 meters (49 feet) of conglomerate, with scattered large pebbles and cobbles up to 25 centimeters (9.84 inches) in size in a sandy matrix. The gravel consists of both felsic and basaltic rocks that are well rounded, with a sand matrix supporting the cobbles and pebbles. Cementation of this unit ranges from slight to moderate. The upper contact of unit E is not identified easily at the IDF site. In the western part of the study area, unconsolidated gravels of the Hanford formation directly overly the Ringold Formation unit E gravels, making exact placement of the contact difficult. The dominance of basalt and the absence of cementation in the Hanford formation are the key criteria used to distinguishing these (PNNL-11957, 1998). In the central and northeast part of the area, unit E has been eroded completely. Unconsolidated gravels and sands typical of the Hanford formation replace unit E.

Unconformity at the Top of the Ringold Formation. The surface of the Ringold Formation is irregular in the area of the IDF site. A northwest-southeast trending erosional channel or trough is centered through the northeast portion of the site. The trough is deepest near borehole 299-E24-21 in the northern part of the site (PNNL-13652, 2001). This trough is interpreted as part of a larger trough under the 200 East Area, resulting from scouring by the Missoula floods.

Hanford formation. The Hanford formation is as much as 116 meters (381 feet) thick in and around the IDF site. The Hanford formation thickens in the erosional channel cut into the Ringold Formation and thins to the southwest along the margin of the channel.

At the IDF site, the Hanford formation consists mainly of sand dominated facies and less amounts of silt dominated and gravel dominated facies. The Hanford formation has been described as poorly sorted pebble to boulder gravel and fine- to coarse-grained sand, with lesser amounts of interstitial and interbedded silt and clay. In previous studies of the site (WHC-MR-0391, 1991), the Hanford formation was described as consisting of three units: an upper and lower gravel facies and a sand facies between the two gravelly units. The upper gravel dominated facies appears to be thin or absent in the immediate area of the IDF site (PNNL-12257, 1999; PNNL-13652, 2001; PNNL-14029, 2002).

The lowermost part of the Hanford formation encountered in boreholes at the IDF site consists of the gravel-dominated facies. Drill core and cuttings from boreholes 299-E17-21, 299-E17-22, 299-E17-23, 299-E17-25, and 299-E24-21 indicate that the unit is a clast-supported pebble- to cobble-gravel with minor amounts of sand in the matrix. The cobbles and pebbles almost are exclusively basalt, with no cementation. This unit pinches out west of the IDF site and thickens to the east and northeast (Figure 3-4). The water table beneath the IDF site is located in the lower gravel unit. The lower gravel unit is interpreted to be Missoula flood gravels, deposited in the erosional channel carved into the underlying Ringold Formation.

The upper portion of the Hanford formation consists of at least 73 meters (240 feet) of fine-to coarse-grained sand, with minor amounts of silt and clay and some gravelly sands.

Holocene Deposits. Holocene, eolian deposits cover the southern part of the IDF site. Caliche coatings on the bottom of pebbles and cobbles in drill cores through this unit are typical of Holocene caliche development in the Columbia Basin. The southern part of the IDF site is capped by a stabilized sand dune. The eolian unit is composed of fine- to coarse-grained sands with abundant silt, as layers and as material mixed with the sand.

Clastic Dikes. A clastic dike was encountered in borehole C3828, adjacent to well 299-E17-25 at the IDF site. Clastic dikes also have been observed in excavations surrounding the site (e.g., U.S. Ecology, the former Grout area, the 216-BC cribs, the Central Landfill, and the Environmental Restoration Disposal Facility [PNNL, BHI-01103]). In undisturbed areas such as the IDF site, clastic dikes typically are not observed because these are covered by wind blown sediments. The occurrence of a clastic dike in borehole C3828 suggests that these probably are present elsewhere in the subsurface at the disposal site.

3.4.3 Seismology

The IDF will be located in Zone 2B, as identified in the UBC (DOE/RL-91-28). The analyses in Sections 5.1 and 5.12 provide additional seismic detail for design of liner and structural systems.

No active faults, or evidence of a fault that has had a displacement during Holocene times, have been found on the Hanford Site (DOE/RL-91-28). The youngest faults recognized on the Hanford Site occur on Gable Mountain, over 4.5 kilometers (2.78 miles) north of the 200 East Area. These faults are Quaternary of age and are considered 'capable' by the Nuclear Regulatory Commission (DOE/RL-91-28).

3.5 Hydrology

The following paragraphs briefly describe the known hydrology conditions of the Hanford Site and most specifically the 200 Area Plateau where the IDF site is located. These are prepared from information in the *ILAW Preliminary Closure Plan for the Disposal Facility* (RPP-6911).

3.5.1 Surface Water

The IDF site is within the 200 East area, which is on a plateau above the Columbia River. The Columbia River runs generally to the east and swings around the site, lying about 8 miles northwest and northeast of the 200 East area. The project area is significantly higher than the Columbia River and is not in the river's floodplain.

The soils in the project area are sandy with high rates of infiltration. Most of the precipitation falling on the site infiltrates into the ground, and there are no significant long-term surface water features in the project area.

3.5.2 Groundwater

The geologic structure of the 200 East area is composed of multiple layers of sediments that range from sand, silt, volcanic ash, and clay to coarse gravels, cobbles, and conglomerates that overlay thick layers of basaltic lava. An unconfined aquifer exists in the lower part of the sedimentary sequence, overlaying the uppermost basalt layer. This relatively thin aquifer intercepts infiltration from the unsaturated zone above it. The aquifer under the IDF site is approximately 90 to 100 meters (300 to 330 feet) below the ground surface. Therefore, the groundwater table is well below the proposed bottom of the excavation for the IDF and is not expected to influence the facility. The recharge of water into the ground at the IDF site is expected to be small. This condition results primarily from the low levels of annual precipitation that occur in the region of the IDF as well as the rest of the Hanford Site. A more detailed description of groundwater beneath the IDF, developed from various site explorations performed in the site area, is presented below.

The unconfined aquifer under the IDF site occurs in the fluvial gravels of the Ringold Formation and flood deposits of the Hanford formation. The thickness of the aquifer ranges from about 70 meters (230 feet) at the southwest corner of the site to about 30 meters (98 feet) under the northeast corner of the IDF site. The Elephant Mountain Member of the Columbia River Basalt Group forms the base of the unconfined aquifer (Figure 3-3).

The unsaturated zone beneath the land surface at the IDF site is approximately 100 meters (328 feet) thick and consists of the Hanford formation. The water level in boreholes in and around the site indicates that the water table is in the lower gravel sequence of the Hanford formation and at an elevation of approximately 123 meters (404 feet) above sea level. The water table is nearly flat beneath the IDF site. Table 3-1 gives water level information from wells near the site. The locations of the wells are shown on Figure 3-1. The latest water table map shows less than about 0.1 meter (3.94 inches) of hydraulic head across the IDF site (PNNL-13404, 2001).

The Ringold Formation lower mud unit occurs within the aquifer at the southwest corner of the IDF site (299-E17-21) but is absent in the central and northern parts of the site (299-E24-7 and 299-E24-21). The lower mud unit is known to be a confining or partly confining layer at places under the Hanford Site (PNNL-12261, 2000), and this might be the case under the southwest corner of the IDF site. Groundwater samples were collected and analyzed from above and below the lower mud unit during drilling of well 299-E17-21. Chemical parameters (pH, electrical conductivity, and Eh) were different in the two samples, suggesting that the lower mud is at least partly confining in the area. No contamination was found above or below the lower mud. An interpretation of the distribution and thickness of this stratum is shown in Figure 3-4. The surface of the lower mud unit is interpreted to dip gently to the southwest (PNNL-13652, 2001).

Hydrographs for selected wells near the IDF site are shown in Figures 3-5 and 3-6. Hydrographs for the older wells (299-E23-1, 299-E23-2, and 299-E24-7) show two maxima in the water level. These coincide with the operation of the PUREX Plant that operated between 1956 and 1972 and between 1983 and 1988. All the hydrographs show a decline in the water table during recent years. The rate of decline is between 0.18 and 0.22 meters (7.08 and 8.66 inches)/year and will take between 10 and 30 years to stabilize. The reason for the decline is the cessation of effluent discharge to the PUREX Plant and to the 216-B Pond System, centered northeast of 200 East area. Based on hindcast water table maps (PNNL, BNWL-B-360), the water table is expected to decline another 2 to 7 meters (7 to 23 feet) before reaching pre-Hanford Site elevations. The cessations of effluent discharge also are responsible for changing the direction of groundwater flow across much of the 200 East area.

Groundwater flow beneath the IDF site recently was modeled to be southeasterly (PNNL-13400, 2000). This direction differs from the easterly direction, predicted by the analysis of WHC-SD-WM-RPT-241 and other earlier reports. The southeasterly flow direction primarily is attributable to inclusion of the highly permeable Hanford formation sediments in the ancestral Columbia River/Missoula flood channel in the analysis. A southeasterly flow direction is reflected in the geographic distribution of the regional nitrate and tritium plumes in the south-central 200 East area (Figure 3-7) (PNNL-13788, 2002.). As stated in PNNL-13404 (2001), the water table gradient is too low to be used for determining flow direction or flow rate at the PUREX Plant cribs, immediately east of the IDF site.

Hydraulic conductivity directly beneath the IDF site was estimated from data collected during four slug tests at well 299-E17-21 and five slug tests of 299-E24-21. The interval tested at 299-E17-21 was the upper 7.8 meters (26 feet) of the unconfined aquifer from 101.3 to 109.1 meters (332 to 358 feet) depth. That portion of the aquifer is Hanford formation gravel, from 101.3 to 102.1 meters (332 to 335 feet) depth, and Ringold Formation unit E gravels, from 102.1 to 109.1 meters (335 to 358 feet) depth (PNNL-12257, 1999). The interval tested at well 299-E24-21 was entirely in the Hanford formation gravel sequence between 95.2 and 101.3 meters (312 and 332 feet) depth. The best-fit value to the data from 299-E17-21 indicated a hydraulic conductivity of about 68.6 meters (225 feet) per day (PNNL-12257, 1999), and that from 299-E24-21 suggested a hydraulic conductivity of 75 meters (246 feet) per day (PNNL-13652, 2001).

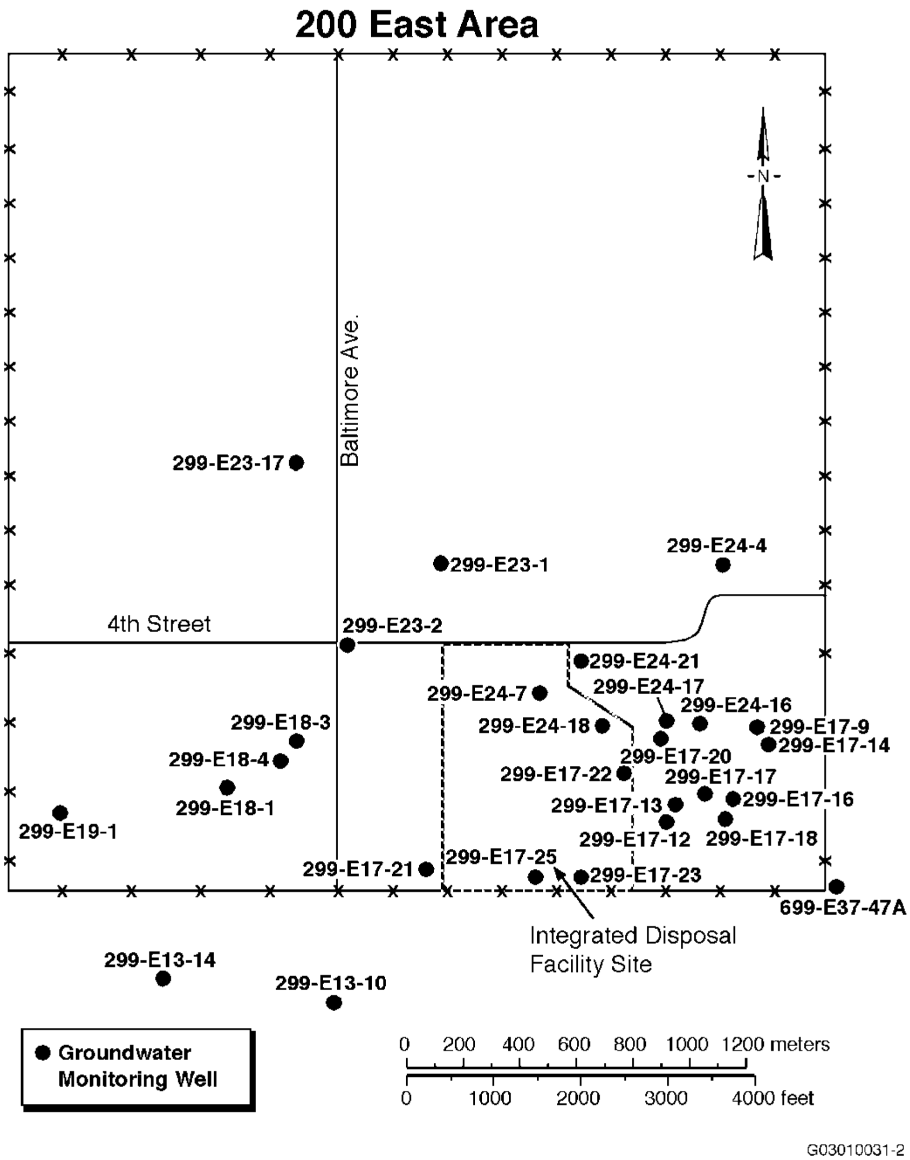
Table 3-1. Water Levels in Groundwater Wells in the Vicinity of the IDF Site

Well	Measure date	DTW m[a]	WT elev m[b]	Ref elev m[c]
299-E13-10	3/14/02	101.7	122.5	226.31
299-E17-12	3/14/02	100.0	121.1	221.09
299-E17-13	4/12/01	97.7	122.6	220.34
299-E17-17	4/12/99	97.8	122.8	220.54
299-E17-18	10/3/02	98.5	122.3	220.76
299-E17-20	4/9/97	97.1	123.2	220.33
299-E17-21	4/23/98	100.4	122.7	224.26
299-E17-22	5/20/02	98.1	122.5	220.59
299-E17-23	5/20/02	101.6	122.2	223.84
299-E17-25	5/21/02	98.3	126.7	225.03
299-E18-1	3/14/02	98.2	122.4	220.65
299-E18-3	6/27/96	97.8	123.4	221.20
299-E18-4	6/27/96	97.7	123.4	221.05
299-E19-1	3/22/88	100.4	124.9	225.26
299-E23-1	3/14/02	96.0	122.4	218.39
299-E23-2	12/20/94	97.2	123.5	220.77
299-E24-4	8/10/98	90.6	122.9	213.47
299-E24-7	6/11/97	96.2	123.2	219.34
299-E24-16	10/4/02	97.7	122.3	220.02
299-E24-17	4/7/97	97.36	122.9	220.16
299-E24-18	10/2/02	98.0	122.3	220.35
299-E24-21	3/22/01	95.4	122.6	217.85

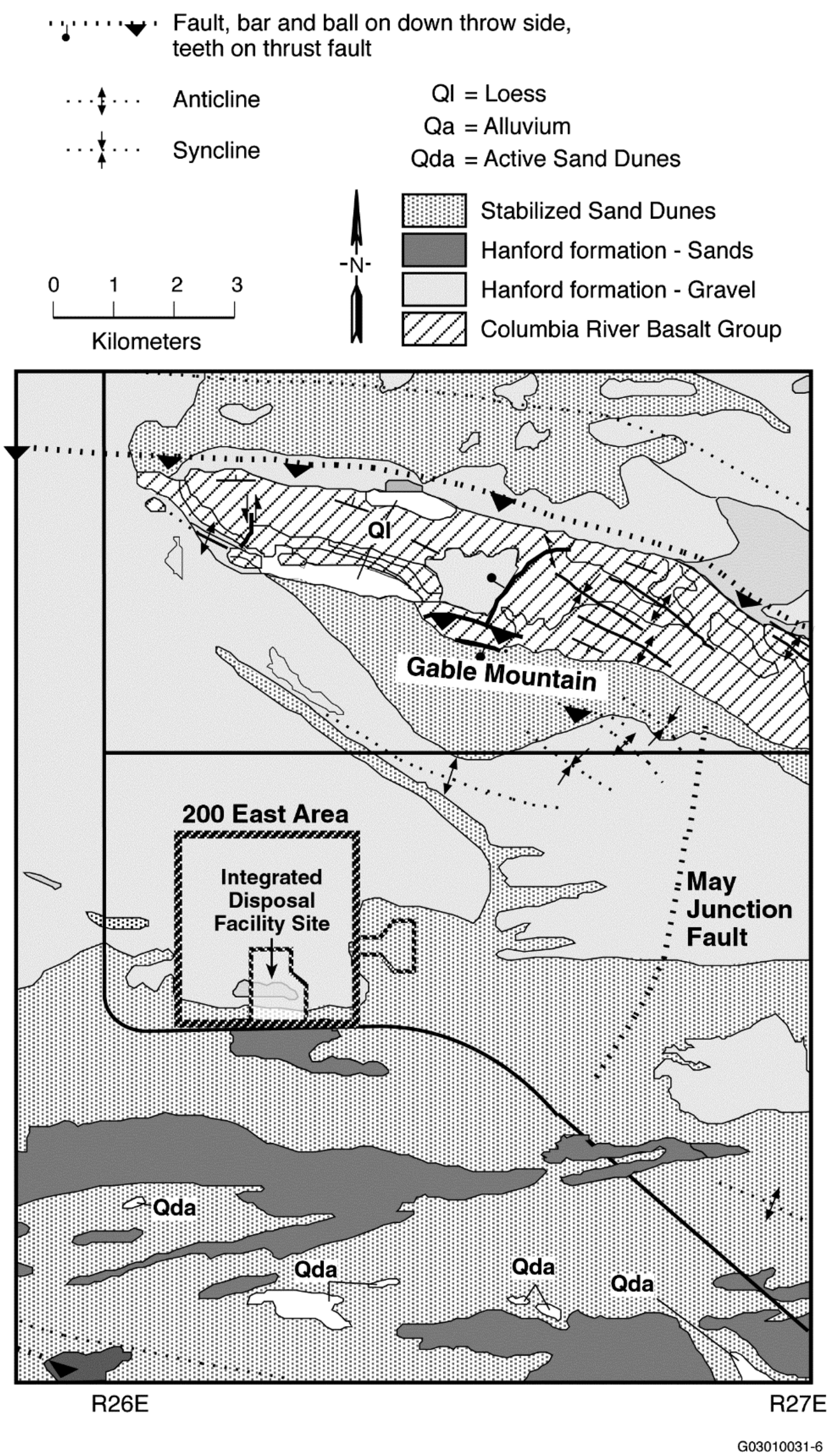
a DTW = depth to water

b WT elev = elevation of water table (meters above mean sea level)

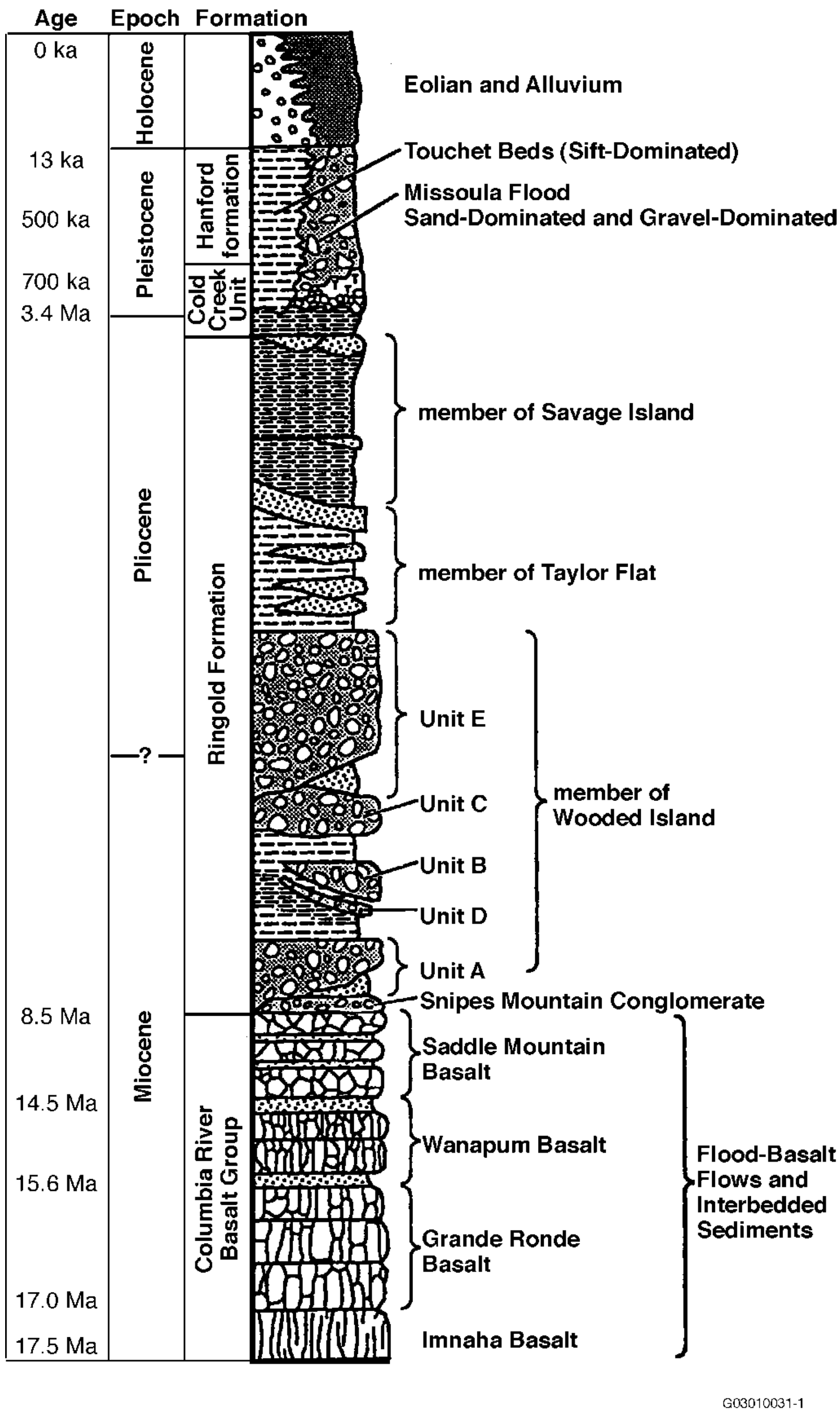
c Ref elev = reference elevation (meters above mean sea level, North American Vertical Datam 88 reference), generally top of well casing.



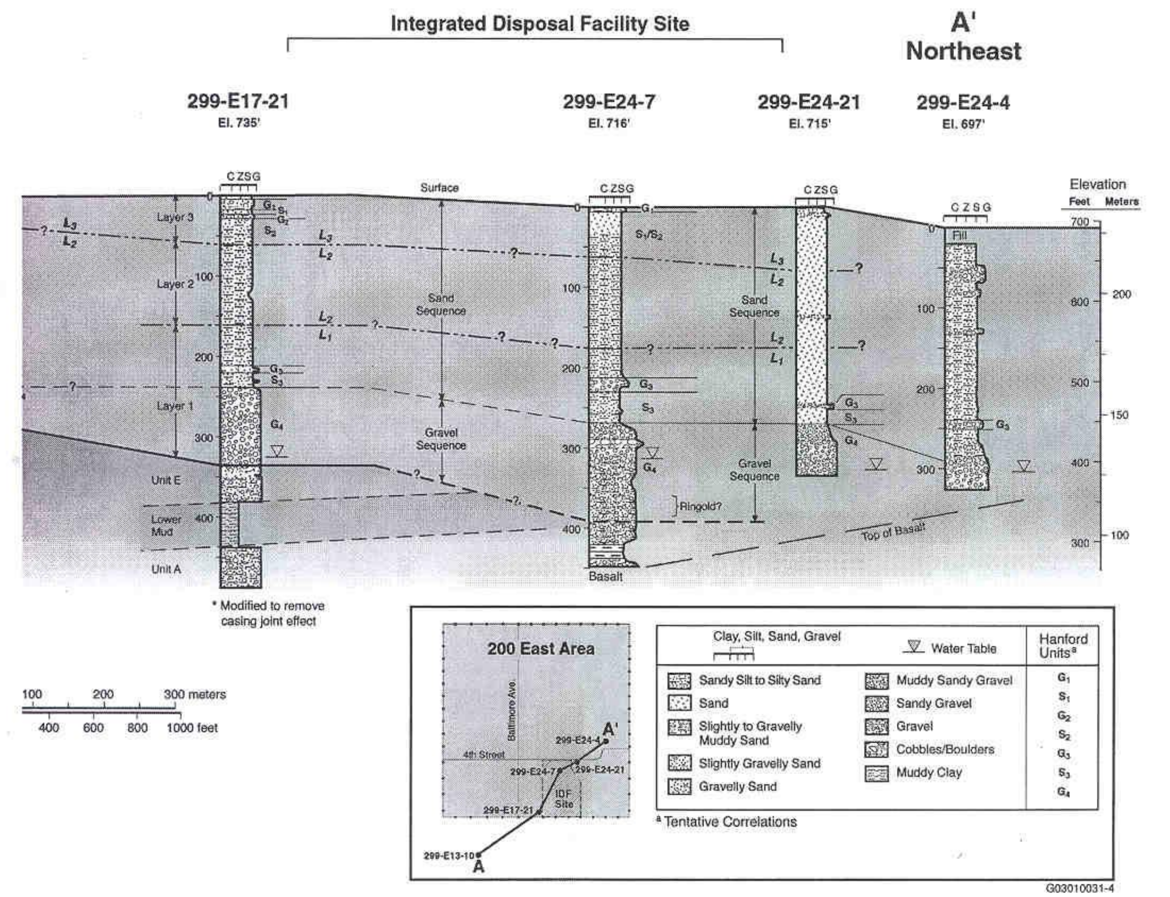
1 **Figure 3-1. Location of the IDF and Nearby Boreholes**



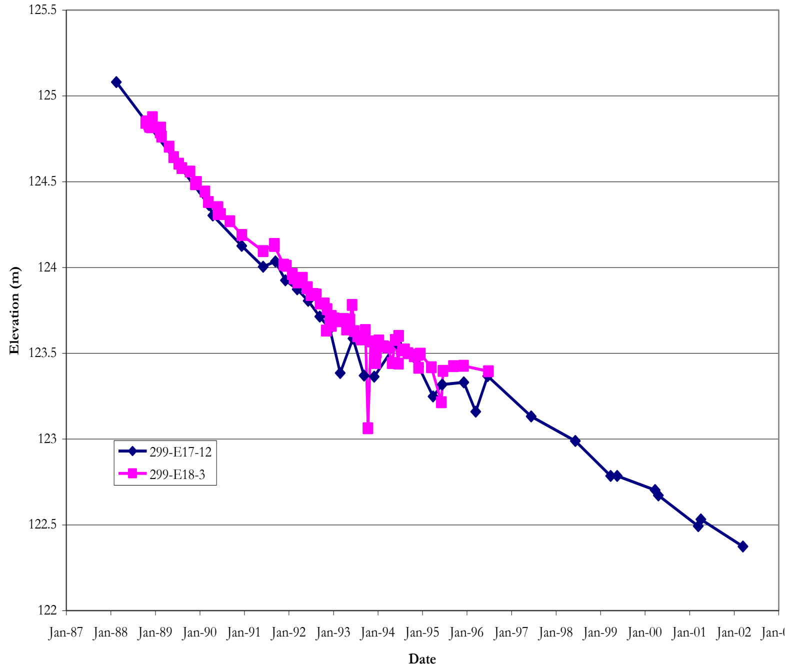
1 **Figure 3-2. Geologic Map of the 200 East and 200 West Areas and Vicinity**

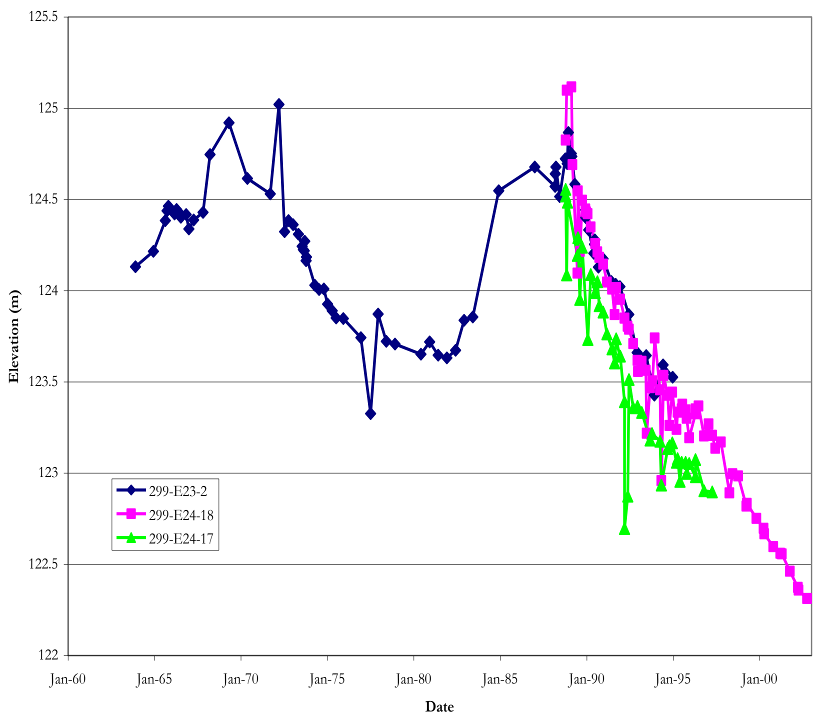


1 **Figure 3-3. Stratigraphy of the Hanford Site**

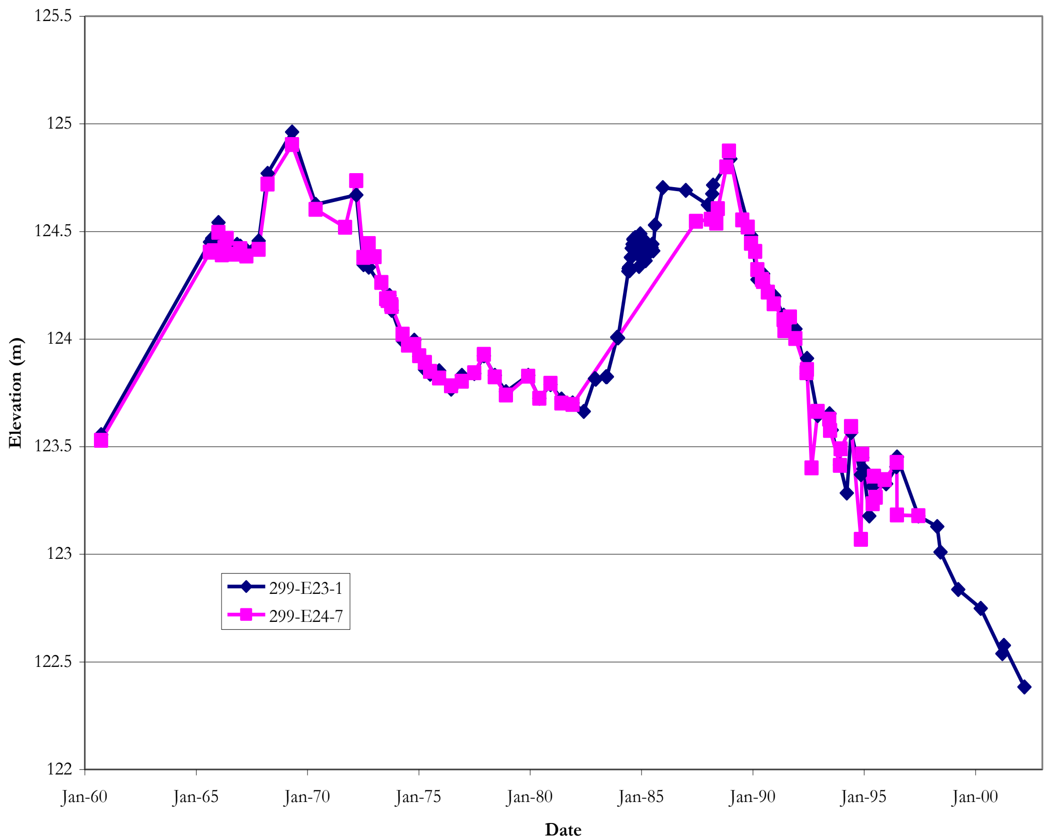


1 **Figure 3-4. Cross-section through the IDF Site (refer to Figure 3-1 for boring**
2 **exploration locations)**

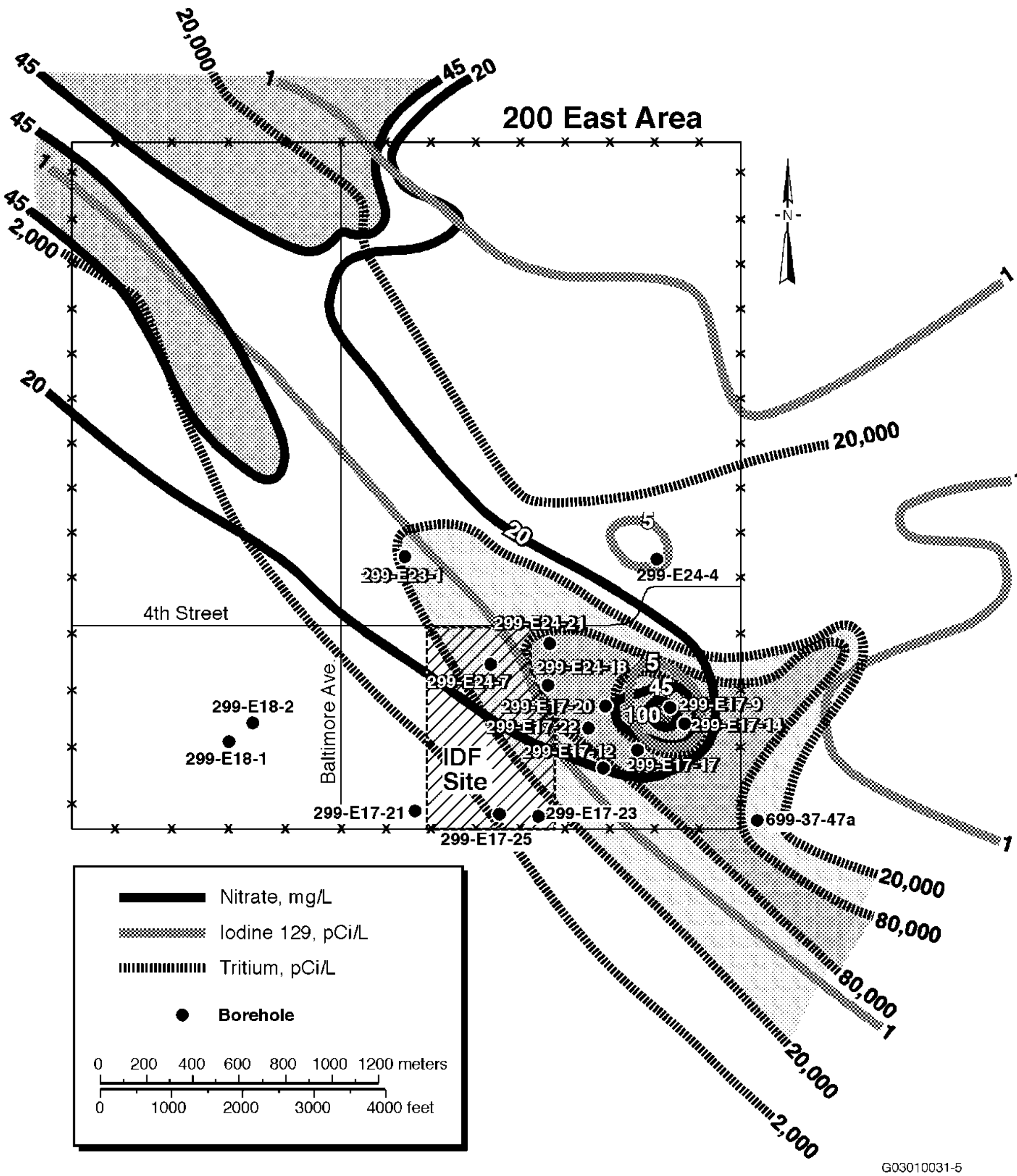




1 **Figure 3-5. Hydrographs for Wells Near the IDF Site (1 and 2 of 3)**



1 **Figure 3-6. Hydrographs for Wells Near the IDF Site (3 of 3)**



1 **Figure 3-7. Contaminant Plume Map for the 200 East Area**

4.0 SITE INVESTIGATION AND LABORATORY TEST PROGRAM

This section presents a summary of the existing, current, and planned explorations for the IDF, along with the laboratory test results for tests conducted during this design effort.

4.1 Field Explorations

This section discusses the existing and current soil explorations for the IDF. The generalized soil profile used in the analysis and design is presented; the engineering soil properties used for design are presented and discussed in Section 5 and related appendices.

4.1.1 Existing Explorations

Several field explorations have been conducted in the general area of the IDF, as discussed in Section 3.4.1 and presented in Figure 3-1. Figure 1-2 shows the current IDF footprint and the closest borings to the planned facility. As shown in Figure 1-2, with the exception of one boring, the existing explorations are all outside of the footprint of the IDF.

The existing field explorations at the IDF site have been conducted primarily for geologic and hydrogeologic characterization on a "big picture" scale. The existing explorations provide detailed information for the purposes for which they were conducted; however, from a geotechnical engineering perspective, the existing borings at or near the IDF site provides only general information, as discussed below.

Depth of Interest–In many cases, the explorations focused on providing detailed information for the entire soil column above the bedrock at the IDF site (300 or more feet below ground surface [bgs]). The primary depth of interest for detailed engineering and design purposes is the depth of the planned cell excavation (roughly 50 feet below the existing ground surface); for a few analyses, information about the material 25 to 50 feet below the base of the excavation is also important.

Type of Information–As intended, the existing explorations was generally focused on providing information for geologic characterization purposes. This focus differs from the key items generally required for geotechnical design, including Standard Penetration Testing (SPT) per ASTM requirements and classification by the Unified Soil Classification System (USCS) in both the field and the laboratory. For coarse-grained soils (sands and gravels), that make up the bulk of the native soil profile, *in situ* SPT in conjunction with grain-size data is the primary basis for determining geotechnical engineering parameters of the soil, such as shear strength. In all cases the SPT values were either not readily available or were conducted with non-standard equipment. Also, the existing grain size data and soil classifications, both for field and laboratory results were based on the Wentworth scale, which differs from the USCS scale at the gravel and fines divisions. These are the key division points for classifying coarse-grained soils. In particular, the break point for fines contents is important in determining the suitability of the excavated soils for use in the admix liner as well as for other on-site filling purposes. Many of the soils within the depth of interest for the IDF are near this classification break point.

Proximity to the IDF–As shown in Figure 1-2, in nearly all cases the explorations were located outside of the IDF footprint. The standard of practice for geotechnical engineering is to place explorations within or very close to the footprint of the proposed structure, if possible.

There have been several geotechnically focused explorations conducted for various projects at Hanford. The projects closest and/or most applicable to the IDF site are:

The Grout Vault project, located approximately one-half mile east of the IDF site (Dames and Moore, 1988).

The W-025 Project, a radioactive mixed-waste land disposal facility designed in accordance with RCRA Subtitle C design criteria, located several miles west of the IDF site (in Area 200W, Golder Associates, 1995, 1994a, 1994b, and 1988).

The RPP-WTP, location approximately 1 mile east of the IDF site (Shannon and Wilson, 2000 and 2001).

These projects all provide geotechnical engineering information; however, the closest site is one-half-mile from the IDF. The standard of care for geotechnical engineering is to either use existing geotechnically based information that is at the site and/or conduct site and project specific explorations. This is to verify that the soil conditions at the site are either still valid (no changes since the time of the existing explorations) or are consistent with existing data.

4.1.2 Current Explorations

Due to the limits of the geotechnical specific data, a subsurface exploration plan specific to the Phase I portion of the IDF was proposed. The suggested locations for the exploration are shown in Figure 1-2. This exploration is currently in planning.

During this design effort, a limited surface sampling plan was conducted at the locations shown in Figure 1-2. The surface samples were taken from the upper 2 to 3 feet of soil, primarily to provide samples for admix testing (to determine if the soils were suitable as a base soil), as well as to help fill in for the absence of a full exploration program at the time of this design effort. As shown in Figure 1-2, samples were taken from primarily from the dune sand borrow area within the IDF footprint (SD-1 through SD-4) and the active sand borrow area (SD-5) to the east of the IDF footprint. One surface sample (SD-6) was obtained from within the IDF Phase I limits.

4.1.3 Site Stratigraphy

In the absence of a comprehensive site and project specific geotechnical engineering data, the existing and current data discussed above was reviewed to determine appropriate soil profile and geotechnical parameters for use in engineering analysis and design. The stratigraphy and soil properties were generally selected conservatively to account for the uncertainty in the subsurface information. The general soil stratigraphy beneath the Phase I section of the IDF was assumed to be:

- 10 feet of Dune (Eolian) sand, overlying
- 50 feet of Upper Hanford sand, overlying

Lower Hanford sand to depth of interest.

It is expected that a greater depth of Dune sand exists in the southern portion of the IDF footprint (note topographic change in the southern one-third of the IDF footprint in Figure 1-2).

The engineering properties and parameters assumed for these soil units were based on the information provided in the geotechnical reports listed in the previous section. The individual values are discussed in Section 5 and related appendices.

4.1.4 Future Explorations

It is recommended that a comprehensive, geotechnically focused exploration program be completed, prior to construction, to verify that the assumptions made for soil stratigraphy and engineering properties are valid. A more comprehensive set of explorations is currently being planned. The planned locations for the additional explorations are shown in Figure 1-2, and include three explorations within the Phase I footprint and one exploration in the proposed sand borrow area.

4.2 Laboratory Testing

A limited laboratory testing program was conducted, using the soils collected during the surface sampling program discussed in Section 4.1.3. These samples were used to perform the index testing, admix testing, and geosynthetics interface shear testing.

4.2.1 Index Testing

Index testing was performed to evaluate the basic index and classification properties of the soil obtained from surface sampling program. This testing was conducted to provide data for comparison with both the soils used for the W025 admix liner and also for other soils that are considered for use as the base soil for the IDF project, as the final design and construction proceeds.

The laboratory testing was conducted by Soil Technology, Inc., (STI) of Bainbridge Island, Washington, under subcontract to the Affiliate. Test assignment and coordination was provided by the Affiliate. Index testing included the following ASTM tests:

- ASTM D422 – Test Method for Particle-Size Analysis of Soils (grain size and hydrometer analyses)
- ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM D1140 – Test Method for Amount of Material in Soils Finer then the No. 200 Sieve (P200 Wash)
- ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Efforts
- ASTM D2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
- Compaction characteristics were also determined for a composite of the surface soils, as described in the next section.

4.2.2 Admix Testing Program

The admix testing program was developed to determine two key items:

- Percentage of sodium bentonite required to meet hydraulic conductivity requirements
- Appropriate moisture and density parameters to achieve the required hydraulic conductivity

Index testing of the admix soils was also conducted, as well as a consolidation test. The laboratory testing was conducted by STI. Tests were run in general accordance with the following:

- ASTM D422 – Test Method for Particle-Size Analysis of Soils (grain size and hydrometer analyses)
- ASTM D698B – Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
- ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Efforts
- ASTM D2216 – Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
- ASTM D2435 – Test Method for One-dimensional Consolidation Properties of Soils
- ASTM D4318 – Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)
- ASTM D5084 – Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

The base soil for the admix testing was created by compositing SD-1 through SD-4 from the surface sampling program. This composite did not include SD-5, taken at the base of the existing sand borrow area (lower elevation than the other samples) that has slightly different properties than the remainder of the surface samples. SD-6 was not included at the time of the admix testing because it is not within the footprint of the planned borrow area. The base composite sample was labeled as COMP-1. This composite was then used to create the two other soils for admix testing:

- COMP-2: COMP-1 base soil mixed with 8 percent bentonite
- COMP-3: COMP-1 base soil mixed with 12 percent bentonite
- Moisture and density testing was conducted on all of the composite samples.

The initial hydraulic conductivity testing was conducted using eight and 12 percent bentonite (by weight), based on the results of the admix testing program conducted by Golder for the W025 Project (Golder, 1991b). The target laboratory hydraulic conductivity was less than 10-8 cm/sec when permeated with water. Testing was not conducted with leachate, as no actual leachate exists for the planned waste at this time. Golder Associates used a synthetic leachate to perform compatibility testing on the admix liner. Based on these results, they increased the bentonite percentage from 8 to 12 percent, hence the use of these values in these tests. Because the base soils are expected to be similar to that used by Golder for the W025 landfill, and until a more refined characterization of the IDF leachate is developed, the compatibility testing performed for the W025 project was considered applicable to the IDF project. Hydraulic conductivity testing was performed on all samples in flexible wall triaxial cells with backpressure saturation, in general accordance with ASTM D5084. An effective confining stress of 5 pounds per square in (psi) was applied to each test cell. Appendix B.1 includes the details for the test, including the inflow and outflow data used to confirm that each test had obtained a steady-state hydraulic conductivity value.

After the initial hydraulic conductivity testing was completed, additional samples were set up to determine the range of moisture and density parameters that are expected to produce the required hydraulic conductivity in the field.

As noted above, the samples used for the testing were gathered from the surface sampling program. Once a more comprehensive exploration program is conducted within the IDF footprint, the suitability of the soils within the excavation below a depth of 5 feet (upper 2-3 feet) can be examined for use as a base soil for the admix.

4.2.3 Geosynthetics Interface Shear Testing

A limited soil-to-geosynthetic interface shear testing program was conducted to determine the interface shear values between the operations soil and the composite drainage net (CDN), and the admix liner soils and the high-density polyethylene (HDPE). These interfaces are site specific because of the unique nature of the soils, hence their behavior in interface shear. The testing was conducted by Precision Geotechnical Laboratories in Anaheim, California. Soil samples collected during the surface sampling program were used for testing; GSE Lining Technologies, Inc. based in Houston, Texas provided the geosynthetics for testing.

The interface shear tests were conducted in general accordance with ASTM D5321–Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method. The tests were conducted for both low (100 to 500 psf) and high (1000 to 8000 psf) normal stress levels, to account for the variation in normal stresses that will be applied across the lining system in the final landfill configuration. Both the peak and residual strength values were determined during testing. Additional details for the tests are presented with the test results in Appendix B.2.

Asperity testing was also conducted on the textured HDPE geomembrane, in general accordance with GRI-GM12 – *Asperity Height of Textured Geomembrane*. The purpose of the asperity testing was to establish a baseline roughness of the texturing of the HDPE geomembrane and for future assessments of the interface shear strength of other textured HDPE geomembrane products (e.g., from other manufacturers).

Site-specific interface shear testing was not conducted for geosynthetic-to-geosynthetic (such as CDN to geosynthetic clay liner [GCL]) interfaces in this phase of design, as these values are primarily a function of the manufactured product properties. A database of values for geosynthetic-to-geosynthetic interface testing was used to determine the appropriate interface shear values for design. During construction, the actual materials used on the site will be tested as part of the construction QC/QA, to ensure that the installed materials used onsite meet or exceed the interface shear strength values used in the design.

4.3 Laboratory Test Results

The results of the laboratory testing programs are summarized below and presented in Appendix B.1 and Appendix B.2.

4.3.1 Index Testing

The results of the index testing for the surface samples are presented in Table 4-1. The test results are included with the admix liner soils test results in Appendix B.1. Results of the index testing indicate that the grain size analyses for near-surface soil samples from locations SD-1 through SD-6 correlate well with data from the W025 base soil material. The W025 base soil was a dune sand (Eolian deposits) obtained from the upper 15 feet of site excavations. As discussed in Section 5.4, based on the results shown below and due to the limited nature of the near surface soil samples, the base soil is limited to the upper 5 feet of material excavated from the dune sand borrow area or the Phase I site excavation.

Table 4-1. Results of the Base Soil Index Testing

Test	Sample #	% Gravel	% Sand	% Fines	OMC, w_{opt} (%)	MDD, $\square_{dmax}$ (pcf)
Grain Size Testing	SD#1			22.5	--	--
	SD#2		72.2	27.8	--	--
	SD#3			17.5	--	--
	SD#4		78.1	21.9	--	--
	SD#5	2.4	58.5	39.1	--	--
	SD#6		79.5	20.5	--	--
Standard Compaction	SD#6	--	--	--	14	106.6

OMC = optimum moisture content
MDD = maximum dry density

4.3.2 Admix Liner Soils Test Results

The results of the testing program conducted on the admix liner soils are summarized in Tables 4-2 and 4-3 and presented in detail in Appendix B.1. The associated placement and testing requirements during construction are also discussed in detail in Section 5.4.

Table 4-2. Results of the Admix Hydraulic Conductivity Testing

Sample ID	OMC (%)	MDD (pcf)	Remolded MC (%)	Remolded Wet Density (pcf)	Relative Compaction (%)	Saturated Hydraulic Conductivity (cm/sec)[a]	Gradient
COMP2-1	12.8[b]	117.2[b]	13.5	127	95	$2x10^{-8}$	11
COMP2-2	12.8[b]	117.2[b]	17.7	123	89	$4x10^{-8}$	10
COMP3-1	13.0[b]	115.5[b]	13.2	124	95	$<1x10^{-8}$	10
COMP3-2	13.0[b]	115.5[b]	17.4	122	90	$<1x10^{-8}$	10
COMP3-3	10.0[c]	126.3[c]	10.3	136	98	$<1x10^{-8}$	12
COMP3-4	10.0[c]	126.3[c]	14.2	139	96	$<1x10^{-8}$	10
COMP3-5	10.0[c]	126.3[c]	8	130	95	$<1x10^{-8}$	18

Table 4-2. Results of the Admix Hydraulic Conductivity Testing

Sample ID	OMC (%)	MDD (pcf)	Remolded MC (%)	Remolded Wet Density (pcf)	Relative Compaction (%)	Saturated Hydraulic Conductivity (cm/sec)[a]	Gradient
COMP3-6	13.0[b]	115.5[b]	10	115	91	$1x10^{-8}$	21
COMP3-7	10.0[c]	126.3[c]	10	123	89	$<1x10^{-8}$	20
COMP3-8	13.0[b]	115.5[b]	11	119	93	$<1x10^{-8}$	16

Abbreviations: OMC = optimum moisture content MDD = maximum dry density pcf = pounds per cubic foot
MC = moisture content
COMP 2 samples had 8 percent bentonite.
COMP-3 samples had 12 percent bentonite.
Average saturated hydraulic conductivity using tap water
Based on standard Proctor compaction curve (D698).
Based on modified Proctor compaction curve (D1557)

Table 4-3. Results of Admix Liner Soils Index Testing

Test	Sample #	% Gravel	% Sand	% Fines	LL (%)	PI (%)
Grain Size Testing	COMP-1	--	77.5	22.5	--	--
	COMP-2	--	70.6	29.4	--	--
	COMP-3	--	68.7	31.3	--	--
Atterberg Limits	COMP-2	--	--	--	40	17
	COMP-3	--	--	--	54	32

LL = Liquid Limit
PI = Plasticity Index

Consolidation testing conducted on the admix liner soils is presented with the rest of the results in Appendix B.1. This results of this test were used for the settlement analysis discussed in Section 5.3.1.

4.3.3 Geosynthetics Interface Shear Tests

The results of the geosynthetic testing program are presented in Table 4-4; the results of the asperity are shown in Appendix B.2. The results are discussed in detail in Sections 5.1.1 and 5.1.3, and their related appendices (Appendix C.1.a and C.1.c, respectively).

Table 4-4. Summary of Geosynthetic Testing

	Test	Peak Friction Angle (°)	Peak Cohesion (psf)	Residual Friction Angle (°)	Residual Cohesion (psf)	Asperity	Comments
Low	Operations Soil-CDN Interface	29.6	205.9	24.6	205.4	--	– Test #1 – dry density = 92 pcf – w_c = 8.7%

Table 4-4. Summary of Geosynthetic Testing

	Test	Peak Friction Angle (°)	Peak Cohesion (psf)	Residual Friction Angle (°)	Residual Cohesion (psf)	Asperity	Comments
	Admix Soil-HDPE Interface	33.3	94.4	33.5	56.8	--	– Test #3 – dry density = 110 pcf – w_c = 14%
High Normal Stress	Operations Soil-CDN Interface	28.3	283.9	28	240.8	--	– Test #2 – dry density = 92 pcf – w_c = 8.7%
High Normal Stress	Admix Soil-HDPE Interface	25.4	400.7	20.3	525.3	--	– Test #4 – dry density = 110 pcf – w_c = 14%
	Textured HDPE Asperity	--	--	--	--	23.5	Average value of two test results of 22 and 25.

As the final design progress and additional information is gathered for the admix soils and the operations soils, these results should be verified with additional testing. Testing during full scale construction is also planned to verify that the materials used in construction, both soils and geosynthetics, produce interface shear values at or greater than those used for design.

5.0 ENGINEERING ANALYSIS

This detailed Design Report finalizes the design for the landfill liner system, the leachate removal system, and the LDS. Engineering analysis components for each of these critical systems is presented in this section. A general description of system components is located in Section 5.6.1, that presents the primary and secondary liner systems that make up the major layers of the landfill (detailed system descriptions are presented in Section 6).

In preparation of the IDF design, a number of design requirements and criteria as presented in Section 2 have been considered. Compliance with these design requirements is provided in Appendix A. The specific criteria evaluated for the IDF design included:

- Slope stability
- Landfill bearing capacity
- Settlement and uplift analyses
- Admix liner
- Geosynthetic liner design
- Liner systems/leachate compatibility
- Drainage layer
- Leachate production
- Leachate collection system
- Surface stormwater
- Action leakage rate
- Building systems analyses
- Civil grading

5.1 Slope Stability

Slope stability for the IDF landfill was examined for liner veneer (side slope) stability, earthwork stability, waste/fill global stability. The analyses for each of these cases are summarized in the sections below; Appendices C.1.a through C.1.c presents the analyses and results in detail.

5.1.1 Liner Veneer (Side Slope) Stability

The veneer stability of the liner system on the side slopes was evaluated for the period prior to waste filling. The analysis examined the potential for sliding of the drainage and operations layers on the liner system before waste is placed.

The analyses were conducted using the weakest of the interface strengths of the various lining system components. The interface strengths were determined from regression analyses of data gathered from various sources, including site-specific test data completed to date. Based on the data (presented in Appendix C.1.a), the critical interface is the textured HDPE/CDN interface. Properties of the cover soil (operations layer) were determined from laboratory testing to date on the materials expected to be used for the operations layer.

Four loading conditions were examined:

- Dead load: self-weight of the lining system (including the first operations layer)
- Dead load + Equipment: self-weight of the lining system with an equipment load
- Dead load + Seepage: self-weight of the lining system with a seepage load (to account for fluid head in the leachate collection system); seepage loads were based on results from the leachate system hydraulic analyses
- Seismic Loading: self-weight of the lining system with seismic loading

The results of the analyses show that the lining system is stable for the conditions analyzed and no anchorage forces are required to meet the minimum factors of safety (1.5 for dead load only; 1.3 for equipment and seepage loading). A minimum interface friction of 25 degrees and cohesion of 0 psf is required to meet the minimum acceptable factors of safety. The slopes are also considered to be stable under seismic loading, based on comparing the calculated yield acceleration and with the design acceleration values provided in the design criteria by CH2M HILL (September, 2002), using the hazard classification assigned to the overall facility.

The critical interface friction values will be verified during construction to ensure that the system will be stable. The analyses and results are presented in full detail in Appendix C.1.a.

5.1.2 Earthwork Stability

The earthwork stability analysis covered the following three cases:

Excavation Case: This case covers the stability of the landfill slopes immediately after excavation and before placement of the lining system. Only static loading was considered since this is an interim configuration that will only exist for the construction period.

Ramp Case: This case covers the stability of the landfill slopes and access ramp at the south end of the cell, including equipment loading on the ramps. Both static and seismic loading were examined, as the access ramps are expected to be in use for a period of at least 10 years.

Dike Case: This case covers the stability of the perimeter dike (shine berm and access road) after construction of the dike and before final closure of the landfill. Both static and seismic loading were examined, since the perimeter dike may be in place until the final cover system is completed (greater than 10 years).

Properties for the native soils are based on existing information, as a site-specific geotechnical engineering investigation program has not yet been completed for the IDF facility. When this investigation is completed, the results of this analysis (and any others that rely on the properties of the native soils) will be verified. Geometry used in the analyses is based on the civil plans (generally 3H:1V slopes with a few short 2H:1V slopes).

The results of the analyses show that the planned configurations of the landfill are stable under static loading (factor of safety [FS] greater than 1.3 and 1.5, depending on the case analyzed); the configurations are also considered seismically stable based on the criteria for the Hanford site. Full details on the analysis method, the input data, and the results are presented in Appendix C.1.b.

5.1.3 Waste/Fill Global Stability

This analysis examined the following conditions:

Phase I Full Build-Out: This case examined the stability of the waste mass in full build-out of the Phase I waste cell. The critical stability examined was the waste sliding on the lining system. Both static and seismic loading conditions were examined.

Final Configuration: This case examined the stability of the waste mass at the final configuration (entire IDF landfill completed) along the edge of the cover system. Only static loading conditions were examined, since this system is not being designed as part of the current effort.

Interim filling conditions and the internal stability of the waste mass were not examined. The internal waste mass stability will primarily be a function of the filling methodology. Possible filling plans for the waste are currently being developed.

For the analysis of the full build-out of Phase I, the critical interface strengths in the lining system were determined in the same way as for the veneer stability (regression analyses of existing and site specific testing data). A combination of peak and residual strengths were used, based on methodology currently being employed in the state of the practice. A final check was also made to confirm that the use of residual strengths in all locations resulted in a factor of safety greater than 1.0.

The results show that the system is stable for the configurations analyzed and for the interface friction values available at the time of the analyses (FS greater than 1.5 in static loading and yield acceleration greater than the 10,000-year event). The system also has a FS greater than 1.0 for the case of residual strengths in all locations. The critical interfaces are the HDPE-CDN on the side slopes (using residual strengths) and the HDPE-GCL on the base liner (using peak strengths) and the internal GCL strength (using residual strengths). These results should be verified when additional site-specific test data becomes available prior to and during construction.

Also, it should be noted that for the full Phase I build-out configuration, the most critical case appears to be a failure surface that is allowed to propagate through the waste mass. As noted previously, the waste mass was considered internally stable for this design effort. During final operations planning, the internal stability of the waste will be examined in conjunction with the proposed waste filling plan.

For the final configuration with the cover in place, the preliminary geometry and assumed cover system properties show that the configuration is stable under static loading (FS greater than 1.5) and the critical failure does not intersect the waste mass. Stability of the final configuration under both static and seismic loading should be examined in more detail as the final design develops for the final closure of the entire IDF facility.

A full discussion of the methodology, input data, and the results is presented in Appendix C.1.c.

5.2 Landfill Bearing Capacity

5.2.1 Subgrade Soil

Based on the available geotechnical data from other projects (as discussed in Section 4), the strength of the native subgrade soils beneath the landfill is expected to be greater than that for the operations layer or any of the liner system components. Greater strengths equate to higher bearing capacities, and hence, the bearing capacity of the subgrade soils within the landfill cell was not determined directly as they are not the controlling factor.

The bearing capacity of the subgrade soils beneath the supporting structures adjacent to the landfill cell was determined for the structural analyses, discussed under Section 5.12.1–Geotechnical Design Parameters, and the results of the analyses are presented in Appendix C.11.a.

5.2.2 Liner Soils

The soil layers in the lining system include the operations layer, drain gravel, and the admix liner soils. The admix liner soils will be placed beneath the geosynthetic lining system, and as such, loading on the admix liner soils is limited to the allowable loads for the GCL. The allowable loads for the GCL are much less than what the bearing capacity of the admix liner soils would be (the admix soils have much higher strengths, particularly for bearing pressures). The drain gravel will be placed just above the lining system; the shear strength and associated bearing capacity are also much greater than the GCL allowable values.

At the time of these calculations, structures that would cause bearing pressure were not yet determined. Hence, the bearing capacity for the operations soils was calculated for foundation widths from 1 to 10 feet and for 2 different shapes (square and strip). Properties for the operations soils were based on laboratory testing conducted to date; these properties will be verified during construction to ensure that the analyses results are valid.

For a factor of safety of 3, the allowable bearing capacities for the operations layer are presented in Table 5-1.

Table 5-1. Operations Soil Bearing Capacities

B, Foundation Width (feet)	q_{all}, square foundation (tsf)	q_{all}, strip foundation (tsf)
1	0.20	0.33
5	1.0	1.6
10	2.0	3.3

As the operations plans are further developed, these values can be updated for the planned structures (such as barrier walls). Details of the analyses are presented in Appendix C.2.

5.3 Settlement and Uplift Analyses

5.3.1 Settlement Analysis of Liner Foundation

The long term settlement of the soils supporting the geosynthetic liner system was estimated based on the maximum loading expected in the landfill at the final IDF completion. The two soil units examined were the admix liner soils and the native subgrade soils. For the admix soils, data from laboratory consolidation testing performed on samples available at the time of the analysis were used to determine the estimated settlements. Elastic methods were used to estimate the settlements of the subgrade soils.

As detailed in Appendix C.3, the estimated long term settlement over the lifetime of the landfill is 2.7 feet under the maximum loading.

5.3.2 Subsidence and Sinkhole Potential

Subsidence of undisturbed foundation materials is generally the result of dissolution, fluid extraction (water or petroleum), or mining. Subsidence is not expected to occur based on the following:

- The soils underlying the IDF are generally dense, coarse-grained, and well-graded sands and gravels that will not be subject to piping effects that could transport soil and result in subsidence. Also, sands and gravels are generally not susceptible to dissolution.
- The groundwater level is deep and will not affect bearing soils.
- The bedrock is basalt (volcanic), which is not generally susceptible to dissolution.
- No mining or tunneling has been reported in the areas beneath or surrounding the site for the IDF.

- Borings in and around the IDF have not identified any soluble materials in the foundation soils or underlying sediments. Consequently, the potential for any sinkhole development will be negligible.

5.3.3 Uplift Potential

The potential for uplift of the composite liner system is very low. The seasonal high-water level is over 200 feet below the base of the base of the landfill cell, so no external hydrostatic pressure is expected from this source. Perched groundwater is not expected to occur due to the absence of continuous aquitards (such as a clay layer) within the coarse-grained native soils at the IDF site. Any infiltration that does occur is expected to percolate rapidly to deeper soil layers.

Gas pressures are also expected to be negligible, as no gas-generating material (i.e., organic material) is expected in the foundation soils. Also, the subgrade soils are coarse grained and unsaturated, so any gas that might occur is expected to be rapidly dissipated.

5.4 Admix Liner

5.4.1 Mix Design

WAC 173-303-665(2)(h)(i)(B) requires that the lower component of a composite bottom liner be constructed of compacted soil material with an in-situ hydraulic conductivity no greater than 10-7 cm/sec. Because of the lack of naturally occurring soils on-site that could achieve this requirement, a test program was developed to determine the admixture requirements for a mixed soil design using on-site base soil from either the Phase I excavation or dune sand borrow area (see Drawing H-2-830826 for location) and sodium bentonite. Details of the base soil field exploration and admix testing program are provided in Section 4.

The results of the limited field exploration for base soil samples and subsequent admix testing program discussed in Section 4 show that a nominal bentonite content of 12 percent will meet the laboratory target hydraulic conductivity of less than 10-8 cm/sec when permeated with water. The laboratory target was established based on results of the soil liner/leachate compatibility study (Golder Associates, 1991b) for the W025 landfill. Details of Golder's study are discussed in Section 5.6. The W025 study concluded that the bentonite content of the admix should be increased from 8 percent (the minimum bentonite percent needed to achieve the required hydraulic conductivity) to 12 percent, to provide adequate resistance against high inorganic concentrations in the synthetic leachate for the W025 project. Index laboratory testing on the limited field exploration at the IDF site (surface sampling) established that the base soil for the IDF was similar to the W-025 project, as discussed in Section 4. Thus, until a more refined characterization of the IDF leachate is developed, the compatibility testing from the W025 testing is applicable to the IDF mix design.

Once initial hydraulic testing confirmed that an admix with 12 percent bentonite content could achieve the laboratory target value, additional samples were set up to evaluate a range of moisture and density parameters and their effect on hydraulic conductivity. The additional hydraulic conductivity tests were performed to define moisture content-density requirements for a range of compactive energy, as outlined by Daniel and Benson (1990). This data was being used to develop an "acceptable" zone of moisture and density for use by QC personnel during construction. The acceptable zone for the 12 percent admix is presented along with the admix design laboratory test results in Appendix B.1.

The acceptable zone was developed based on samples that achieved a hydraulic conductivity of less than 10-8 cm/sec. A lower bound of 95 percent relative compaction, based on Standard Proctor (ASTM D698) compactive effort, was established to ensure adequate shear strength levels. As indicated in the technical specifications (see Section 02666), the moisture-density range of the compacted admixes shall lie within a trapezoidal-shaped field with the following corners:

Moisture Content (%)	Dry Density (pcf)
8	126
14	126
12	110
19	110

Note that the minimum dry density of 110 listed above corresponds to approximately 95 percent of the maximum dry density for admix, as measured by ASTM D698.

5.4.2 Placement and Testing

The moisture-density requirements developed as part of the admix testing program will be included in the specifications for the admix liner (see discussion in Section 5.4.1, and technical specifications, Section 02666). The intent of the placement technical specifications is to help ensure that the admix liner will meet an in-place performance specification for hydraulic conductivity of less than 1x10-7 cm/sec. The contractor is responsible for developing and implementing compaction means and methods that will produce the required relative compaction.

The recommended nominal bentonite percentage (12 percent) and moisture-density parameters for the admix liner have been developed with a one order of magnitude factor of safety between laboratory and field values for hydraulic conductivity. The factor of safety is expected to account for two issues: (1) variations in the hydraulic conductivity between the laboratory soil amendment study and full-scale production, and (2) the laboratory samples were permeated with water rather than leachate, which could lead to a difference in the field hydraulic conductivity. However, factors such as base soil variability at the borrow source and field placement and construction are difficult to quantify until full-scale production begins for the admix liner. A test pad will be constructed as part the IDF construction to model the full-scale production. The purpose of the test pad is to determine acceptable processing, placement, and compaction methods that will produce a low-hydraulic conductivity admix liner with an *in situ* hydraulic conductivity of 10-7 cm/sec or less. The bentonite percentage and moisture content/density range may be modified if the preconstruction testing performed on the test pad indicates an *in situ* hydraulic conductivity greater than 10-7 cm/sec. Construction QA sampling and testing for the test pad is described in the Detailed Design Cell 1 Construction QA Plan (CH2M HILL, March 2004).

5.4.3 Freeze/Thaw

Compacted soil liners, such as the IDF admix liner, are known to be vulnerable to large increases in hydraulic conductivity due to freeze/thaw cycling; current data suggests that compacted soil bentonite admixtures may not be as vulnerable to damage as true clay liners (Kim and Daniel, 1992; Benson and Othman, 1993; Kraus et al., 1997). Existing laboratory data indicate that GCLs are less susceptible to damage from freeze/thaw conditions and therefore, do not undergo increases in hydraulic conductivity (Hewitt and Daniel, 1997; Kraus et al., 1997).

In order to provide adequate freeze/thaw protection for the admix liner and avoid potential damage to the GCL a protective soil cover can be used. The thickness of the protective soil cover should exceed the predicted freeze depth. For the IDF, protective soil cover is provided by the operations layer on the side slope (3 feet) and the drain gravel and operation layer (4 feet total) on the bottom liner.

The analysis was performed on the IDF lining system operations layer to determine the freeze depth or frost penetration for a probable freezing season during the 10-year expected period of waste filling.

Both a 10-year return period (90 percent probability on non-exceedance) and 20-year return period (95 percent probability on non-exceedance) air freeze index (AFI) were used to estimate maximum frost penetration depth in the operations layer. If the maximum frost penetration depth were less than the 3-foot minimum thickness operations layer over the lining system, the proposed operations layer thickness would be considered as adequate protection for exposure of the lining system to freeze-thaw cycles.

For the 10-year return AFI, the maximum freeze depth is estimated at 17 inches. For the 20-year return AFI, the maximum freeze depth is estimated at 21 inches. The maximum estimated freeze depths for both the 10-year and 20-year return period freezing seasons indicate that the proposed cover soil thicknesses provide more than adequate protection for the underlying admix liner and GCL from potential damage when subject to freeze-thaw cycles. Details of the freeze depth calculations are included in Appendix C.4.

5.5 Geosynthetic Liner Design

5.5.1 Geomembrane Liner Tension Caused By Thermal Contraction

The HDPE geomembrane for IDF lining system will be subject to temperature-induced tensile strain from expansion/contraction as the geomembrane is exposed to temperature fluctuation.

Strain on the liner was calculated using published values for the coefficient of linear thermal expansion for HDPE geomembrane (Koerner, 1998) and applying this to the maximum slope length. The maximum length is measured from the top of the slope, where liner is anchored, to the toe of the 3H:1V side slope. This is a conservative approach, as using the maximum slope length results in the maximum amount of expansion and strain on the liner. Additionally, a conservative temperature change of 40 degrees C (104 degrees F) was used in the analysis.

The maximum liner strain was estimated to be less than 0.5 percent, based on a maximum temperature change of 40 degrees C (104 degrees F). The estimated maximum of slack in the liner on the side slope is 8.6 inches. The corresponding amount of temperature induced stress is 566 psi. See Appendix C.5.a for supporting calculations.

As shown in the technical specifications, Section 02661 (Table 1), the elongation at yield for the geomembrane that will be used in the liner system is at least 12 percent, with a minimum tensile strength at yield of 2,000 psi. Therefore, the maximum anticipated strains are well below the yield tensile strain and stress for the HDPE geomembrane, and temperature-induced strain will have no adverse impact on lining system function.

It should be noted that temperature-induced strain is only applicable during the construction period when the HDPE geomembrane is exposed to temperature fluctuation. Once covered with 3 to 4 feet of cover soils (drain gravel and operations layer), the ambient temperature at the surface of the geomembrane will be more controlled and not subject to fluctuation.

During installation, care must be taken to allow for expansion/contraction of the HDPE geomembrane to minimize the development of wrinkles that could become future stress points under soil and waste loading. The technical specifications (see Section 02661) provide requirements for control of wrinkle development during liner deployment, including the limitation of working when the temperature is below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F) without implementing installation procedures that address the environmental conditions.

5.5.2 Liner System Strain Due To Settlement

The barrier components (geomembrane and GCL) for the IDF lining system will be subject to settlement-induced tensile strains as the underlying soils, primarily the admix soil liner and the subgrade soil, settle over time. Strain within the lining system was calculated based on the results of the liner foundation settlement calculations (see Section 5.3 for settlement of foundation soil [subgrade] and admix liner).

The strain calculation assumed that all vertical settlement was translated into strain along the liner rather than just the vector component parallel to the liner. This is a conservative assumption that establishes an upper bound for liner strain.

The maximum liner strain was estimated to be less than 0.6 percent, based on a maximum estimate of 2.7 feet of settlement at the base of the lining system. See Appendix C.5.b for supporting calculations.

As shown the technical specification (Section 02661, Table 1), the elongation at yield for the geomembrane that will be used in the liner system is at least 12 percent. Based on studies of effect of differential settlement on GCLs (LaGatta et al., 1997), the limiting strain was defined as the strain in which an increase in hydraulic conductivity of the GCL was observed, which was taken as 5 percent.

Therefore, the maximum anticipated strains are well below the yield or limiting tensile strain for the barrier components of the lining system (geomembrane and GCL). Settlement-induced strain from foundation and admix soil settlement under maximum landfill content pressure will have no adverse impact on lining system function.

5.5.3 Anchor Trench Pullout Resistance

During construction, the geomembrane could experience pullout forces caused by thermal expansion/contraction or wind uplift. However, tension from thermal expansion and contraction is expected to be small (see Section 5.5.1), and the geosynthetics installer can use sand bags or other approved method to control wind uplift during installation.

After construction and placement of operation layer, the pullout forces on the geomembrane are expected to be negligible, as there is no tension force on the liner. As indicated in the veneer (side slope) stability analyses (see Section 5.1.1), the lining system interface strength exceeds the slope angle on the 3H:1V side slope. Thus, the pullout resistance requirements for the anchor trench are to support the self-weight of the geomembrane and other lining system components. Analyses for liner self-weight support requirements determined that the frictional resistance between geosynthetics exceeds the liner self-weight. Thus, no additional pullout resistance is needed at the anchor trench to support lining system self-weight.

Supporting calculations for the anchor trench design, as shown on Drawing H-2-830838, Detail 3, are included in Appendix C.5.c. Based on the calculations for the configuration shown in the drawing, a pullout resistance ranging from 1840 pound/foot (lb/ft) to 2440 lb/ft is estimated (depending on actual mobilized interface shear strength). The required minimum tensile yield strength for 60-mil HDPE geomembrane in the technical specifications (see Section 02661) is 1440 lb/ft (120 lb/in), which results in the estimated pullout resistance exceeding the geomembrane tensile yield strength. This situation is due primarily to the configuration of the shine berm, which helps to anchor the system. While it is generally not desired for the pullout resistance to exceed the yield strength, this is not expected to be a problem at the IDF, since, as discussed above, the potential causes for geomembrane tension have been addressed and there is not a scenario for mobilizing tensile or pullout forces on the lining system.

5.5.4 Puncture Resistance

The primary geomembrane in the IDF will be overlain by the LCRS. For the side slope lining system, the LCRS consists of a CDN (see Detail 2 on Drawing H-2-830838) that provides protection for the primary geomembrane from the overlying operations layer. A separate discussion of the CDN geotextile puncture resistance is provided in Section 5.7.2. For the bottom lining (floor) system, the LCRS consists of drain gravel overlying the geomembrane (see Detail 1 on Drawing H-2-830838). A geotextile cushion will be required between the drainage gravel and the geomembrane to prevent the gravel from puncturing the geomembrane. An analysis was performed to determine the weight of the geotextile fabric required to prevent geomembrane puncture either from operating equipment loads or from the combined static weight of the waste and final cover.

Koerner (1998) developed a method for estimating required geotextile thickness that considers the size and shape of the rock, as well as other factors that could decrease the long-term strength of the geomembrane. The equation used to determine puncture resistance is based on the mass per unit area of the geotextile and the protrusion height of the puncturing material.

Operating loads were estimated based on a melter transport trailer operating directly on the surface of the first operations layer. Static loads were estimated for the post-closure condition by using the weight of four layers of ILAW packages with cover soil and a 15-foot-thick closure cover, with a 2 percent grade to the center of the landfill. The static load was more than two times greater than the operating load, and therefore was used as the basis for the puncture analysis. Detail calculations for geomembrane puncture resistance and corresponding cushion geotextile requirements are included in Appendix C.5.d.

The proposed design specifies that the LCRS drainage gravel will have a gradation corresponding to WSDOT Standard Specification 9-03.12(4). This gradation has a maximum stone size of 1 inch. From the curves shown in the detailed calculations, the FS for a 12 oz/yd2 geotextile loaded by 1-inch angular rock is 4.5. For subrounded rock or gravel, this is more representative of the specified drain gravel, the FS increases to 8.9. The specified cushion geotextile (see technical specifications, Section 02371) has a nominal weight of 12 oz/sq yd, and therefore should be adequate to prevent geomembrane puncture. Koerner (1998) recommends a FS greater than 3.0 for the condition of packed stones on a geomembrane, such as would be the case for drain gravel over the geomembrane at the IDF.

5.5.5 Operational/Equipment Loading

The effects of loading on the GCL from construction and operational equipment and activities were examined. The maximum loads from the landfill waste itself were found to produce the highest loading on the geomembrane and the CDN; these materials were selected based on this maximum loading, as discussed in the previous sections.

The cases for construction equipment loading and operational loading on the GCL were examined, including the extreme loading case of the crane placing the heaviest waste loads at its maximum reach, a situation which produces very high pad loads. The expected loads were compared to the calculated allowable GCL bearing capacity to determine if the loads would have an effect on the GCL. The allowable GCL bearing capacity was determined from classical geotechnical theory and based on manufacturer's strength data.

The results of the analyses are presented in detail in Appendix C.5.e. For the construction loading, the analyses show that the specification requirements that limit construction loading are adequate to protect the GCL, based on the standard construction equipment anticipated to be used at the IDF and as examined in the calculations.

For the operational loading cases examined, the critical condition is the crane operating under an extreme condition. The minimum dunnage requirement for the crane pads is 60 square feet, or if square, a 7.7-foot by 7.7-foot dunnage pad. Lower loads will require less dunnage and can be calculated as detailed in Appendix C.5.e. As discussed in the appendix, dunnage requirements calculated in this way are appropriate as long as the lining system is functioning as intended (i.e., no moisture in the LDS). If moisture enters the LDS and the GCL becomes hydrated, the dunnage requirements will be increased by a factor of approximately 2.5.

It should also be noted that the primary purpose of the GCL in the IDF is not as a required lining system component (such as the geomembrane or the admix liner), but to "deflect" leachate from defects or pinholes in the primary geomembrane over the bottom area and longer-term storage areas (such as leachate sump trough), where the leachate head potential is greatest. The primary purpose of the primary GCL is to reduce the actual leakage rate into the LDS in the event of leak in the primary geomembrane. Given these considerations, the GCL should perform as intended under anticipated equipment and operational loading.

As the operations plans for the landfill are developed, loading values can be compared to the results shown in Appendix C.5.e to determine if the loads will affect the GCL.

5.6 Liner Systems/Leachate Compatibility

The purpose of this analysis is to demonstrate that the liner materials proposed for the IDF landfill are chemically compatible with the leachate. Certain materials deteriorate over time when exposed to chemicals that may be contained in hazardous leachate. It is important to anticipate the type and quality of the leachate that the landfill will generate and select compatible liner materials. Data collected from other similar low-level radioactive mixed waste and hazardous waste sites were used in conjunction with the anticipated IDF leachate concentrations to evaluate the allowable concentration of leachate constituents that could be in contact with the IDF landfill liner components.

5.6.1 Lining System Description

Detailed discussion of the lining system design elements is provided in Section 6. A summary is provided in this section to facilitate discussion with respect to the chemical and radiation resistance of the lining system components.

Drawing H-2-830838 (Detail 1) shows the bottom liner section consisting of the following components, from top to bottom:

- A 3-foot-thick operations layer
- A separation geotextile (polypropylene)
- A 1-foot-thick leachate gravel layer
- A minimum 12 oz/square yard cushion geotextile (polypropylene)
- A 60-mil (nominal thickness—see Section 6.3.2.1) textured primary HDPE geomembrane
- An internally-reinforced GCL
- A CDN drainage layer for primary leak detection/collection
- A 60-mil textured secondary HDPE geomembrane
- A 3-foot-thick low-hydraulic conductivity compacted admix (soil-bentonite) liner

For the bottom lining system, both the primary and secondary liners are a composite (geomembrane over admix liner or GCL) system. The addition of a GCL in the primary liner layer provides an extra measure of protection, exceeding the requirements of WAC 173-303-665(2)(h)(i), which stipulates a single geomembrane for the primary liner and composite for the secondary only. This will provide an extra measure of protection on the bottom flatter slopes of the IDF, where higher leachate head levels are more likely.

Drawing H-2-830838 (Detail 2) shows the side slope liner section consisting of the following components, from top to bottom:

- A 3-foot-thick operations layer
- A CDN drainage layer for primary leachate collection
- A 60-mil textured primary HDPE geomembrane
- A CDN drainage layer for primary leak detection/collection
- A 60-mil textured secondary HDPE geomembrane
- A 3-ft-thick low-hydraulic conductivity admix liner

The side slope lining system is a single geomembrane liner over a composite liner, meeting the requirements of WAC 173-303-665(2)(h)(i). The 3H:1V side slopes for the IDF will result in little or no leachate head build-up on the side slope lining system, thus eliminating the need for a lining system design that exceeds the WAC requirements.

In general, the liner system consists of two types of materials, geosynthetics and soil/bentonite mixtures (admix). The geomembranes, geotextiles, and CDN are manufactured from polymeric materials, such as HDPE, and polypropylene, made from synthetic polymers. The GCL consists of a bentonite layer sandwiched between two polypropylene geotextiles to assist in placement and construction. The admix liner is comprised mainly of silt to clay-sized particles, mixed with a silty sand base soil.

5.6.2 Leachate Characterization Assumptions

Several assumptions were made regarding the composition of the leachate concentrations and the applicability of previously conducted studies for this evaluation. Specifically, the studies considered directly applicable to this evaluation were:

- Geosynthetic and Soil Liner/Leachate Compatibility Studies for the W-025 Radioactive Mixed Waste Landfill in Hanford 200 West (Golder Associates, 1991a and 1991b; TRI, 1995; and WHC, 1995)
- Liner/Leachate Compatibility Study for the U.S. Department of Energy's Idaho National Engineering and Environmental Laboratory (INEEL) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Disposal Facility (ICDF) (DOE-ID, 2002).

Using these studies is considered appropriate for the following reasons:

- The leachate for the IDF is expected to have similar or lower concentrations of radionuclides than that used in the W025 facility study (since similar waste streams [other than ILAW] may be accepted).
- The leachate chemistry may be of similar composition to the W025 facility study (since similar waste streams [other than ILAW] may be accepted).
- Soils used in the W025 facility admix design are similar to those that will be used in the IDF admix design and will therefore be compatible.
- Similar technical specifications for the geosynthetics and admix liner used in the W025 facility design will be used in the IDF landfill design.
- A similar technical specification for a GCL used in the ICDF facility will be used in the IDF liner design.

5.6.2.1 Synthetic Leachate Concentrations for W-025 Landfill

The leachate generated for the W025 evaluation reflects both the waste materials and the stabilization agents used during waste preparation. Because the landfill will comply with waste acceptance criteria for WAC dangerous waste and RCRA facilities (as does the IDF), organic materials are not expected to be present in the waste after processing. The proposed geosynthetic materials are susceptible to damage from certain organic compounds but generally are not susceptible to damage from inorganic compounds, even with extreme pH values. As a result, the lack of organic materials results in a relatively benign leachate.

The source leachate generated for the W025 studies, was primarily based on the waste treatment and packaging approaches for W025. An aqueous solution of inorganic, with some organic compounds for conservative evaluation, was generated, resulting in a viscous, slurry-like mixture. This mixture was placed in a leaching column, and deionized water was introduced to simulate the effects of leachate generation. Although no organic components were anticipated in the waste, small quantities of benzene, methanol, and light machine oil were included to simulate the presence of organic compounds in the waste material.

The source leachate generated through the leachate column process was chemically analyzed with the following results:

- Concentrations of organics benzene and machine oil were below detection limits. Concentrations of methanol were detected, but at concentrations not considered aggressive for polyester or HDPE.
- Metals added to the waste were below the detection limits in the source leachate.
- Primary constituents of the source leachate were sodium cations and common inorganic anions, with a pH of 9.2.
- Based on these results, a synthetic leachate was generated for testing purposes. The source leachate formula resulted in a solution with total inorganics and dissolved salts of approximately 204,000 mg/L and pH of 9.2 using NaOH or HNO3, as required.

5.6.2.2 Simulated Irradiation Exposure for W-025 Landfill

Samples used to evaluate the effects of radiation were subjected to a 50,000-rad total dose of gamma radiation. This dose is expected to exceed the maximum level of radiation experienced by geosynthetic materials in the landfill under unfavorable conditions. Use of a total dose, rather than radiation type, is considered the primary factor causing damage to polymeric materials and is considered to adequately simulate actual IDF leachate conditions. Samples and leachate were irradiated together so that any synergistic effects would be seen. The following samples were included in the irradiation testing:

- Geomembrane
- Geotextile
- Geonet
- Admix (soil/bentonite mixture)

The synthetic leachate and radiation exposure developed from the W-025 studies were used as the basis of evaluation for the IDF lining system materials. Table 5-2 provides a comparison of the leachate concentrations for the W-025 project with other studies for which the U.S. Environmental Protection Agency (EPA) Test Method 9090 were performed on the lining system.

The ICDF project did not include EPA 9090 tests, however, a model for estimating leachate concentration based on the waste acceptance criteria for the project was developed. The maximum leachate concentrations and radiation exposure developed for the ICDF (DOE-ID, 2002) based on the anticipated waste design inventory were as follows:

- Organics–70 mg/l
- Inorganics–18,400 mg/l
- Radiation Exposure–12,000 rads

Table 5-2. EPA Test Method 9090 Compatibility Studies Comparison

Compatibility Study[a]	Type of Material Tested	General Composition of Leachate	9090[b] Test Concentrations or Radiation Exposure that Demonstrated Compatibility in Each Study
Hanford Liquid Effluent Retention Facility (LERF)	60-mil smooth HDPE from four manufacturers	Organics	16.25 mg/L
Hanford W-025 Landfill	60-mil smooth HDPE	Inorganics Organic Leachate and Radiation Exposure pH	204,210 mg/L 50,000 rads 9.2
Hanford Grout Facility	60-mil smooth HDPE	Inorganics Organic Leachate and Radiation Exposure pH	368,336 mg/L 37,000,000 rads >14
Kettleman Hills Landfills	60-mil smooth HDPE	Organics Inorganics pH	93,040 mg/L 250,000 mg/L >12

a. Detailed compatibility test information is provided in Evaluation of Liner/Leachate Chemical Compatibility for the Environmental Restoration Disposal Facility report (USACE, 1995).
b. EPA Test Method 9090 "Compatibility Test for Wastes and Membrane Liners" (EPA, 1992c).

A review of the studies presented in Table 5-2 leads to the conclusion that the inorganic concentration developed for the W025 is somewhat conservative as it significantly higher than inorganic concentrations developed for the ICDF facilities. Other than the W-025 landfill, the ICDF is estimated to be most similar to the waste type to be received at the IDF of the studies included in Table 5-2. Nonetheless, the liner/leachate compatibility study for the IDF is based on the W025 synthetic leachate. Further analysis of the applicability of these leachate concentrations is recommended, if the conservative nature of this synthetic leachate requires costly revisions to the lining system to demonstrate compatibility.

5.6.3 Chemical and Radiation Resistance

Leachate will be generated from precipitation events and from water added to the waste for dust control and compaction purposes during operations. In reality, as the landfill nears the end of its operational life, concentrations of contaminants will decrease with time as the leachable waste mass is reduced. During the post-closure period, a robust landfill cover will significantly reduce infiltration, and the corresponding volume of leachate. Soluble contaminants leached from the waste will come in contact with the landfill bottom liner system during the operation period (approximately 10 years for each of the four planned phases) and minimum post closure period (30 years). The geosynthetics and admix lining system components may be in contact with soluble contaminants as long as contaminants are present in the landfill.

The expected chemical make up of the leachate for the IDF landfill was determined based on previously conducted compatibility studies (as discussed above) applicable to the same waste stream (the W025 studies), summarized as follows.

5.6.3.1 Geomembrane

HDPE geomembranes can deteriorate from contact with certain leachates, resulting in a decrease of elongation at failure, an increase in modulus of elasticity, a decrease in the stress at failure, and a loss of ductility.

Studies performed on polymer materials like HDPE show that their properties begin to change after absorbing ionizing radiation between 1,000,000 to 10,000,000 rads (Koerner et al., 1990). The HDPE geomembrane lining the bottom of the landfill will absorb ionizing radiation energy from the leachate generated in the landfill. Energy will be absorbed during the operational life of the landfill, as long as there are liquids with ionizing radionuclides in contact with the geomembranes.

Relevant compatibility studies on HDPE geomembranes have been performed for the W-025 Landfill (Golder, 1991a; TRI, 1995; WHC, 1995). The results of these studies indicate that a HDPE geomembrane will function well as a liner beneath the landfill waste.

EPA Method 9090 tests performed on HDPE geomembrane for the W-025 landfill, using the synthetic leachate solution (assumed representative of IDF leachate concentrations) resulted in no evidence of geomembrane deterioration. A comparison between the anticipated IDF landfill leachate (W-025 Landfill) and that used in compatibility tests for other facilities is summarized in Table 5-2.

Geomembrane samples tested for the W-025 facility did not produce measurable changes in the HDPE liner properties when irradiated for 120 days with a total dose of 50,000 rads. HDPE geomembranes are manufactured with additives, such as carbon black and antioxidants, to improve ductility and durability. The literature also indicates that these additives allow higher doses than standard HDPE material without additives (Kircher and Bowman, 1964). The literature indicates that thin films (i.e., 0.002 inches) of different types of HDPE material alone can become brittle when irradiated at doses between 4,400,000 and 78,000,000 rads. Studies performed using polymer materials, with carbon black and antioxidant additives, show that properties typically begin to change at a total radiation dose of between 1,000,000 and 10,000,000 rads (Koerner et al., 1990).

The manufacturers of the geosynthetic products proposed for the IDF landfill have published maximum allowable concentrations of various chemical compounds that can contact the HDPE geomembrane without adversely affecting its performance. The most recent recommended maximum concentrations of chemicals were obtained from the manufacturers of HDPE geomembrane (meeting the requirements for the IDF technical specifications). A list of the manufacturers' maximum allowable concentrations for specific leachate constituents for HDPE geomembrane and the GCL materials is shown on Table 5-3.

5.6.3.2 Geosynthetic Clay Liner (GCL)

The GCL underlying the geomembrane in the IDF landfill consists of processed sodium bentonite clay, sandwiched between two geotextile fabrics. Sodium bentonite is an ore comprised mainly of the montmorillonite clay mineral with broad, flat, negatively charged platelets that attract water, which hydrates the bentonite. The swelling provides the ability to seal around penetrations, giving the GCL its self-healing properties. A GCL product with Volclay-type sodium bentonite (manufactured by CETCO) is specified for installation at the landfill.

The compatibility of GCL materials is usually demonstrated by permeating the material with leachate and then determining its hydraulic conductivity. Typically, solutions with high concentrations of contaminants or pure products are allowed to permeate a sample under confining pressure and the saturated hydraulic conductivity of the material is determined using ASTM methods such as ASTM D5084. A significant increase in saturated hydraulic conductivity (approximately one order of magnitude) for a sample permeated with leachate, compared with a sample permeated with water, would be an indicator of incompatibility.

Based on review of the published studies (Ruhl and Daniel, 1997; Shackelford, et al., 2000; and EPA, 1995), GCLs perform well unless exposed to high concentrations of divalent cations, very acidic or basic solutions, or solutions with a low dielectric constant (such as gasoline). The leachate expected at the IDF will have a pH of 9.2, which is a mid-range pH. The studies further demonstrate that, when confined under a higher normal load (greater than 2000 psf) or if water is the first wetting liquid (Daniel et al., 1997), GCLs will perform well when exposed to high divalent cation concentrations. The GCL for the IDF lining system is expected to confine under normal loads in excess of 2000 psf as soon as the first lift or waste is placed.

No studies were identified that considered the long-term effects of radiation on the physical properties of GCL materials. Since long-term studies cannot be conducted, conservative radiation limitations have been employed. Low-hydraulic conductivity soils have been used at multiple DOE facilities containing radioactive waste. The only known potential adverse reaction that can occur with a GCL is high heat that could dry out the materials. The amount of radioactivity is expected to be low in the IDF landfill waste and will not generate a significant amount of heat that can desiccate the admix liner. Also, it is assumed that the ILAW packages will be cooled to ambient temperatures prior to placement with the cell.

It should be noted that the operations layer and drain gravel will provide a 3-foot buffer on the side slope and a 4-foot buffer between the liner system and waste for additional thermal protection, if needed.

Sodium bentonite is the primary clay mineral in a GCL that produces the low hydraulic conductivity and high swell potential. Exposure of sodium bentonite to liquids containing concentrated salts (such as brines), or divalent cation concentrations (such as Ca++ and Mg++), reduces the swelling potential and increases its hydraulic conductivity. Concentrated organic solutions (such as hydrocarbons) and strong acids and bases can break down the soil, which also increases hydraulic conductivity. The physical mechanism that causes these changes is a reduction of the thickness, and related absorption capacity, of the diffuse double layer of water molecules surrounding the clay minerals. This results in an effective decrease in the volume of the clay, since the water molecules are not attracted to the clay particles.

The GCL manufacturer allows the use of GCL with few restrictions on maximum chemical concentrations. Leachate concentrations for the IDF landfill (based on synthetic leachate from W025) have relatively high inorganics and dissolved salts. The W025 dissolved salt concentrations are above the manufacturers recommended concentration of 35,000 mg/L (see Table 5-3) (CETCO, 2001). As a point of reference, this concentration of dissolved salts is typical of seawater (USGS, 1989). However, the dissolved salt concentrations in the IDF leachate have been characterized as primarily sodium, and the synthetic leachate was comprised of entirely sodium salts, not the divalent cations such as Ca++ and Mg++, as assumed by the manufacturers. As such, the impact on GCL hydraulic conductivity should be less as compared to divalent cation solutions. Additionally, any effects of leachate degradation on the GCL would be minimized by hydration of the GCLs' sodium bentonite with relatively "fresh" water, allowing the GCL to swell initially and decrease hydraulic conductivity.

The rationale for use of the GCL in the IDF landfill primary liner is to "deflect" leachate from defects or pinholes in the geomembrane over the bottom area and longer-term storage areas (such as the leachate sump trough), where leachate head potential is greatest. The main purpose of the primary GCL is to reduce the actual leakage rate into the LDS in the event of leak in the primary geomembrane (see Section 5.10 and Appendix C.10). The GCL is expected to contact leachate only in the event of a leak in the primary geomembrane. These leachate collection and storage areas are subject to flushing throughout the active life of the landfill due to phased development and fill sequence, resulting in a more dilute leachate in leakage areas prior to attaining maximum leachate concentrations. Based on these considerations, the GCL and landfill liner system approach should perform as intended under the anticipated conditions.

5.6.3.3 Admix Liner

The admix layer consists of onsite silty sand mixed with processed bentonite amendment, similar to that used in the construction of GCLs. The swelling of sodium bentonite provides the ability to seal around soil particles, giving the admix a low hydraulic conductivity and self-healing properties. The compatibility of the admix layer with anticipated irradiation and leachate concentrations were evaluated previously as part of the W025 landfill design (Golder Associates, 1991b). The following summarizes the results of the compatibility testing for the admix layer that are directly applicable to the IDF landfill admix liner, since similar materials will be used in construction. More detailed discussion of the IDF admix liner design is provided in Section 5.4.

In the W025 study, samples of the admix were irradiated, similar to that conducted for the geomembrane layer, as discussed previously. Differences between irradiated and non-irradiated samples were not considered significant based on the results of testing.

The initial W025 admix design contained approximately 8 percent bentonite clay. Testing indicated an acceptable hydraulic conductivity of this admix after hydration in fresh water. However, when hydrated in leachate, some hydraulic conductivity test values were twice the allowable limit and, therefore, this admix formulation was not considered acceptable. This is the same leachate chemistry assumed for the IDF landfill.

It should be noted that there are two factors not considered in the W025 compatibility study (Golder Associates, 1991b) that would mitigate the impact of the synthetic leachate on the 8 percent admix samples, as listed below:

Effective stress for samples–hydraulic conductivity tests were performed with effective stresses of 5-10 psi across sample (equivalent to less than one full lift of ILAW packages). It is well documented that higher effective stresses will lower hydraulic conductivity and mitigate the effects of shrinking/cracking in clay under attack from chemicals. In reality, by the time any leachate contacts the lining system, there will be a substantial stress load on the liner that will mitigate the impacts of chemicals in leachate on the admix liner.

First wetting liquid–W025 tests were performed using both site water and synthetic leachate as the initial wetting fluid. It is well documented that if a clay soil is "attacked" by inorganics prior to saturation, the increase in hydraulic conductivity will be more dramatic than if water is first permeant. This was confirmed by W025 testing–there was an order of magnitude difference between samples with water as first wetting liquid as opposed to leachate. It is reasonable to expect something closer to water than concentrated leachate will be the first wetting liquid for the IDF admix liner.

Due to the results in the W025 testing showing greater than acceptable hydraulic conductivity in the admix when exposed to the W025 synthetic leachate, the bentonite percentage was increased from 8 to 12 percent. An admix containing 12 percent bentonite clay was permeated with synthetic leachate and tested with a resulting hydraulic conductivity that was 3 to 10 times lower than the maximum allowable limit (10-7 cm/sec). This admix formulation was considered acceptable with respect to W025 leachate compatibility and is applicable to the IDF. Thus, the technical specifications (see Section 02666) require a nominal 12 percent (range from 11 to 14 percent is acceptable) bentonite by weight for the admix liner. Consideration should be given to lowering the bentonite percentage upon further characterization of the IDF leachate and applicability of the mitigating factors discussed above.

5.6.3.4 Other Materials

Other materials for which compatibility needs to be addressed are the CDN and geotextiles (cushion, separation, and bonded to geonet of CDN). While these materials do not serve a barrier function, they provide either for removal of leachate or protection of the lining system and must continue to function when exposed to leachate.

During the W025 design, the effect of the synthetic leachate on the geonet core of the CDN and the geotextiles was evaluated (Golder Associates, 1991a). The study concluded that a geonet core comprised of HDPE provided adequate chemical and radiation resistance. For geotextiles, the study concluded that geotextiles made of polyester fabric were susceptible to degradation and recommended that geotextile material be limited to a more chemically resistant material such as polypropylene. The technical specifications for the IDF require that geotextiles be made from polypropylene (see Section 02371); thus, the geotextiles used for the IDF should have adequate chemical and radiation resistance.

Table 5-3. Maximum Allowable Concentrations in Leachate by Chemical Category for Geosynthetic Components

Chemical Category	Compatible Concentration for HDPE	Compatible Concentration for GCL	IDF Concentration Dose or Value
Organics	500,000[a] mg/L	500,000[b] mg/L	N/A
Acids and Bases	750,000[a] mg/L	500,000[b] mg/L	0[d] mg/L
Inorganic	500,000[a] mg/L	500,000[b] mg/L	204,000 mg/L[c]
Dissolved Salts	No Limit	35,000[a] mg/L	204,000 mg/L[c]
Strong Oxidizers	1,000 mg/L	No limit	0 [d] mg/L
Radionuclides	1,000,000[b] rads	No limit	50,000 rads[c]
PH	0.5 - 13.0[a]	0.5 - 13.0	9.2

a. Based on the typical manufacturers' maximum concentration of the list of constituents by the manufacturers.
b. Based on reported literature values.
c. Based on synthetic leachate formula for W-025
d. Strong acids, bases, or oxidizing compounds were not identified in the W-025 compatibility studies.

5.7 Drainage Layer

The drainage layer for the LCRS consists of three components: the separation geotextile, the CDN, and the drainage gravel. Analyses for the drainage layer required evaluation of these components.

5.7.1 Geotextile Analyses (Separation)

Analyses were performed to verify that a separation geotextile between the operations layer and leachate collection drain gravel is required by evaluating natural graded filter criteria for these materials. Results indicated that natural filter criteria could not be achieved, thus a separation geotextile is required between the operations layer and drain gravel. Supporting natural filter calculations are included in Appendix C.6.a.

Analyses were conducted to determine the proper apparent opening size (AOS) and permittivity of the separation geotextile. Required AOS and permittivity were determined based on filter, fines retention, and clogging potential criteria. Results of these analyses were used to develop the technical specifications for the separation geotextile (see Section 02371). Supporting geotextile filter calculations are also included in Appendix C.6.A.

5.7.2 CDN Selection

The CDN selection was based on analysis of two design issues, CDN geotextile puncture resistance and CDN required transmissivity.

5.7.2.1 CDN Geotextile Puncture Resistance

The LCRS CDN layer at the IDF will be overlain by the operations layer on the 3H:1V side slope. The operations layer is allowed to contain a particle size up to 2 inches in dimension. An analysis was performed to determine if the geotextile bonded to geonet (to form the CDN) would be punctured by particles/rocks of this size.

The method developed by Koerner (1998) was used to calculate the puncture resistance. Koerner's method considers the size and shape of the rock, as well as other factors that could decrease the long-term strength of the geotextile. The two loading conditions examined were initial placement of the operations layer and the final depth of waste and closure cover. The geomembrane puncture resistance analysis (see Section 5.5.4) provides the details for the load analysis for these conditions. Detailed calculations for CDN geotextile puncture resistance and corresponding cushion geotextile requirements are included in Appendix C.6.b1.

Results of the analyses indicate that the required puncture resistance is 11.2 lbs. The minimum specified value for Type 1 geotextile (see technical specifications, Section 02371) is 65 lbs. Applying a partial safety factor of 2 gives a minimum resistance of 32.5 lbs. Therefore, the proposed geotextile bonded to the geonet of the CDN will resist puncture with a global safety factor of 2.9; it is adequate for resistance to puncture from the overlying operations layer under the pressure of maximum landfill contents pressure. Koerner (1998) recommends a minimum global safety factor of 2.0.

It should be noted that the results of this analysis are considered conservative because the analytical method assumes only a uniform particle size and does not take the surrounding soil matrix into consideration. This would effectively reduce the particle size by a considerable degree.

5.7.2.2 CDN Required Transmissivity

An additional selection criteria for the CDN is the required transmissivity (or flow rate) under design loading conditions. For the IDF two cases require analysis:

LDS CDN on bottom and side slope–For this case, the critical condition is to ensure that the transmissivity as required by WAC and EPA regulations (3 x 10-5 m2/sec) under the maximum load from the landfill contents can be achieved.

LCRS CDN on side slope only–There are actually two loading conditions for the LCRS CDN on the side slope. One is the open slope condition with operations layer only over the CDN, which is a low normal load (1,000 psf) condition. The second is in the filled condition, which is a high normal load (15,000 psf) condition. Based on the results of leachate production analyses using the Hydrologic Evaluation of Landfill Performance (HELP) model (see Section 5.8), the required transmissivity for the LCRS CDN is 6.5 x 10-5 m2/sec for the open slope condition and 1 x 10-5 m2/sec for the filled condition.

For each case, the approach was to compare the required transmissivity to typical manufacturer's data with test conditions (i.e., normal load and material boundary), similar to the design conditions. The allowable transmissivity (φ) was determined using guidance provided by GRI standard GC-8 (2001), *Determination of the Allowable Flow Rate of a Drainage Geocomposite*. The GRI-GC8 standard uses the following equation:

$\varphi_{allow} = \varphi_{100\ hr\ test}$/Reduction Factors for intrusion, creep, chemical clogging and biological clogging

The FS for design was then determined as follows:

$FS = \varphi_{allow}/\varphi_{required}$

Transmissivity data for the 100-hour test data was obtained from the manufacturer for both 200-mil and 250-mil thickness CDN for normal loads of both 1,000 psf and 15,000 psf. Test data was provided for a number of boundary conditions including flow tests between a geomembrane and a soil, as would be the case for the LCRS or LDS CDN. Test data used as the basis for the analyses are included with the calculations presented in Appendix C.6.b2.

Based on the analyses, a higher flow, thicker (250-mil minimum) CDN is required, due to the reduction of flow under the high normal loads in the final filling configuration. The technical specifications (see Section 02373) provide the required index values for the geonet core of the CDN as well as the CDN itself (with geotextile bonded to both sides of the geonet), based on the results of this analysis. The transmissivity requirements in the technical specifications are index values and not in-service condition values, as determined in this analysis. These index values are representative of testing that manufacturers typically perform in production and are correlated to design conditions using the approach outlined in GRI GC-8.

5.7.3 Drainage Gravel Selection

Section 02315 (Fill and Backfill) in the technical specifications requires that drain gravel meets the requirements of WSDOT 9-03.12(4) for gradation. The technical specifications also require a performance specification for a hydraulic conductivity greater or equal to 10-1 cm/sec.

Hydraulic conductivity of the specified drain gravel was estimated using two different empirical relationships. The most relevant of the two estimates a minimum hydraulic conductivity of 1 cm/sec, based on the specified gradation curve for WSDOT Gravel Backfill for Drains (9-03.12[4]). Supporting calculations are included in Appendix C.6.c.

The minimum estimated hydraulic conductivity for the drain gravel exceeds the required (by WAC and EPA regulations) hydraulic conductivity of 10-2 cm/sec by a factor or 100 to 1,000, and the performance specification hydraulic conductivity of 10-1 cm/sec by a factor of 10 to 100. This exceedance makes an allowance for two items: (1) it allows for the uncertainty in the empirical formulas used to predict hydraulic conductivity, and (2) it also allows for the potential long-term reduction in hydraulic conductivity in the drain gravel as fines from waste filling and the operations layer migrate into the gravel over time.

As part of Construction QA, testing it is recommended that samples of imported drain gravel be tested for conformance with the gradation and hydraulic conductivity requirements in the technical specifications.

5.8 Leachate Production

5.8.1 Leachate Production Analyses

Estimates of the amount of leachate produced during the development and operation of the IDF were needed to design the components of the leachate collection and conveyance system described in Section 5.9, and to provide information necessary when evaluating slope stability of the side slope and bottom liner systems. Leachate is produced when precipitation falls within the lined area and infiltrates vertically through the waste and/or bottom liner system. The amount of infiltration estimated to occur depends on the hydrologic processes and the relative fraction of precipitation that results as leachate and is collected by the leachate collection system.

The water balance components of the hydrologic process were estimated using EPA's *Hydrologic Evaluation of Landfill Performance (HELP) Model* (Schroeder et. al., 1997), a well known standard for water balance modeling. The HELP model has been widely used for evaluating hydrologic conditions and is the standard model used for providing information necessary for the design of landfill systems. Estimates of the water balance components of the hydrologic cycle provided by HELP include precipitation, evapotranspiration, surface water runoff, vertical percolation, soil moisture storage, and lateral drainage in soil layers.

The HELP model requires input of weather data, representing the conditions at the landfill location, soils data representing the various layers of cover soils, waste materials, and soils underlying the waste layers, and other design data used by the model for water balance calculations. A detailed description of the model and modeling inputs are included in Appendix C.7.

The development of the IDF from Phase I through Phase IV was considered to determine the maximum flow condition expected during development and operation of the landfill. That is, various combinations of open and interim closed phases were considered and the combination calculated to produce the maximum amount of leachate was chosen for analysis. The chosen combination was Phase I through III under interim closure condition and Phase IV in the open condition with little or no waste present. The flows from this condition were used to size the LCRS collection piping and pump systems.

Water balance components were taken directly from model output and a spreadsheet was used to calculate the volumes of leachate by multiplying the HELP output parameter by the area of the type of system modeled. For example, the lateral drainage estimated by the HELP model for the uncovered side slope condition in Phase IV development was multiplied by the total side slope area to determine the total volume of leachate from that area. A spreadsheet summarizing the estimated leachate flows is included in Appendix C.7.

The following modeling results were used for various aspects of design of the IDF systems:

LCRS collection system–Modeling results for the peak day event were used to size the leachate collection system piping that conveys flow to the LCRS systems. The peak day event, as predicted by HELP and referenced herein, was a 1.6-inch precipitation event. This event is approximately 25 percent higher than the 25 year, 24 hour peak day storm event of 1.28 inches (Appendix C.9), required by regulations to be used when complying with the maximum 12 inches of head over the liner (WAC 173-303-665, see Section 2). The spacing of the LCRS perforated collection piping and the properties of the drain gravel material that convey lateral drainage flows above the bottom liner geomembrane to the collection piping and LCRS sump area were checked to insure the maximum head buildup above the sump area of the liner system did not exceed the maximum allowed according to regulatory requirements, as outlined in Section 2.

LCRS pump and forcemain systems–Modeling results for the peak day event were used to size the LCRS high flow pump system that conveys flow to the leachate storage tanks and truck loadout facilities.

Average monthly flow rates plus one standard deviation (resulting in a conservatively-high expected flow rate) was used to design the LCRS low flow pump system for pumping from the IDF during average monthly conditions.

Leachate Collection Storage–Volumes for the peak day event and assumptions for the operational rate of removal of leachate from the tanks were used to size the storage tanks. Storage tank sizing is described in Section 5.9.2.2.

Liner system material properties and stability analyses–The lateral drainage layers of the side slope and bottom liner systems were checked to insure the transmissivity of the layers was sufficient to convey lateral flows and maintain less than the maximum head buildup over the liner system. The seepage height above the liner was used when checking the liner system for veneer stability.

5.9 Leachate Collection System

5.9.1 Earth Loading Analyses

5.9.1.1 Leachate System Loading Analyses for Piping within Phase I Liner Limits

Loading over the leachate system piping include all layers of soil materials, wastes, and anticipated traffic loading. The maximum loading occurs over the piping in the LCRS and LDS sump area, because of its low elevation and the height of material–both waste and soil layers–overlying the sumps. Loading calculations from the geosynthetic liner puncture resistance calculations described in Section 5.5.4 were modified to represent the maximum loading in the LCRS/LDS sump area. Other pipes in the Phase I area, including piping outside the sump and the side slope riser piping, will be subjected to less than the maximum loading. The maximum loading is listed in Appendix C.8.a, along with the calculations for pipe sizing required to withstand this anticipated pipe loading.

Pipe wall thickness was selected based on the maximum loading anticipated in the sump area such that the pipe will not fail due to excessive deflection, wall buckling, or wall crushing. All other piping in Phase I outside of the sump area was chosen with the same standard dimension ratio (SDR) to withstand the maximum load. Standard analysis methods, as recommended by the manufacturer of HDPE pipe made from PE3408 type resin, were used to evaluate pipe strength under loading. These standard methods are based on flexible pipe design practice as applied to HDPE piping. The manufacturer's recommended design analysis techniques are based on standard analysis techniques, including the Iowa formula (*Waste Containment Systems, Waste Stabilization, and Landfills Design and Evaluation*, Sharma and Lewis, 1994), with conservative factors of safety. The potential loss of strength due to the perforations in the perforated collection piping was assumed non-significant, based on actual test results of perforated pipe under similar load rates. The pipe material assumed is High Density Polyethylene

PE3408 pipe with a cell classification of 345434C or better. The flexural modulus and material strength of the pipe was per manufacturer's published literature, based on this classification of pipe.

5.9.1.2 Leachate System Loading Analyses for Piping Outside of Phase I Liner Limits

Piping outside the Phase I liner area includes all underground piping between the crest pad building, combined sump, leachate transfer building, storage tank, and tanker truck load out facility (see Drawing H-2-830846, Sheets 1-2). The civil road layout in these areas is generally configured to allow medium to light duty trucks, such as would be used for operations and maintenance activities. The leachate tanker truck accesses the concrete truck load pad only, and would not normally pass over any piping. However, the piping outside the Phase I Liner area was designed for H-20 semi-trailer type loading to be conservative. The same SDR pipe that used for the high loading within the Phase I liner limits as described in Section 5.9.1.1 was assumed for all piping exposed to earth and traffic loading outside of the Phase I liner limits. The expected pipe loading for H-20 loading plus earth load was compared to the loading used for designing the piping inside the Phase I liner limits and was found to be much lower. Since the pipe SDR is sufficiently strong for the maximum loading inside the Phase I limits, it will have more than sufficient strength for loading expected outside the Phase I limits. Calculations for Phase I are included in Appendix C.8.a. The loading calculation for the added pipeline between transfer buildings is available in CHPRC-03955, *Leachate Pipe Loading Calculation*.

5.9.2 Leachate System Hydraulics Analyses

5.9.2.1 Leachate System Hydraulics Analyses

The leachate collection and conveyance system collects leachate that accumulates as a result of precipitation landing within the footprint of the cells, and it conveys the collected leachate from the cells to a storage tank or tanker truck. Perforated collection piping in the LCRS collects and conveys leachate from the bottom liner system and conveys it to a LCRS sump area in both cells. Lateral flow of leachate from the side slope and bottom liner areas also is conveyed directly to the sump area through a high permeability gravel layer and/or geosynthetic drainage net material. Submersible pumps in the LCRS sump and contained within perforated riser pipes convey leachate to the crest pad building and directly to the leachate storage tank or the tanker truck load facility. Hydraulics analysis was conducted to size the gravity flow piping of the LCRS collection piping and the pump and force main system from the sump area to the storage tank and tanker truck load facility. Sizing and design of leachate collection and conveyance systems were based on ultimate build out of the IDF through Phase IV. That is, the components installed as part of the Phase I design are sized for the ultimate configuration and flows estimated through Phase IV.

5.9.2.2 LCRS Gravity Flow Analyses

The LCRS perforated collection piping was sized using standard gravity flow analysis techniques. The pipe size (nominal 12-inch diameter) was chosen as double the minimum size required for cleanout of the pipe to insure any accumulation of fines would not significantly restrict the flow in the pipe, even though the drain gravel surrounding the pipe will have minimal fines present and geotextiles are present in the lining system to further restrict the migration of any fines. The maximum flow used for sizing was the maximum from the HELP predicted maximum day flow rate or the pump flow rate, based on the pump chosen to convey flow out of the cell.

Perforations in the pipe were sized to allow flow rates much higher than the required maximum flow rate out of the cell, with minimal head loss. This assumption was more conservative by virtue of the fact that the main LCRS collection pipe will only collect and convey a portion of the lateral drainage flow from the cell; the drain gravel and CDN will also convey a portion of the flow. Calculations are included in Appendix C.8.b.

5.9.2.3 Leachate System Pumps and Force Mains Analyses

The pump and forcemain systems for conveying leachate out of the cells and into the leachate storage tanks and to the tanker truck load out facility, and the design considerations for each are described below.

Calculations for Phase I are included in Appendix C.8.b. The hydraulic calculation for the added pipeline between transfer builings is available in CHPRC-03956, *Leachate Hydraulic Calculation*.

LCRS pumps and forcemains–The LCRS pumps and forcemains convey leachate out of the cells to storage tanks or the tanker truck load areas. The criteria for pumping capacity is that the maximum head over the sump area of the cell will not be allowed to exceed 12 inches during the peak day event and during normal operations. To meet the requirement for not exceeding the 12-inch criteria for the peak day event, a LCRS high flow pump was sized to handle the expected peak day flow rate, as estimated and described in Section 5.8, Leachate Production. Hydraulic analyses were conducted to size the pump and forcemain piping according to standard practice to convey the maximum flow rate.

A LCRS low flow pump was sized to convey flow out of the cells under normal, monthly operations. The criteria established for the low flow pump was to convey the average monthly flow plus one standard deviation from the cells, assuming the pump could remove that amount of flow with less than continuous operation. The highest value of the average month plus one standard deviation was used for the maximum flow required of the pump. Under lower flow required conditions, the pump would operate near this rate, depending on the system curve head loss characteristics, but would run for a shorter length of time to remove the volume of leachate from the cell.

LDS pump and forcemain–The LDS pump and forcemain conveys flows from leakage through the LCRS sump area, if in the unlikely event any leakage occurs, to the storage tank or tanker truck load out facility. The LDS system is sized to convey the flow equal to the ALR (described in Section 5.11); however, this rate is so small that the pump capacity is much higher than necessary.

Leachate transfer pump to truckload and forcemain–Under normal operations, leachate conveyed out of the IDF will be routed to the leachate storage tank. Periodically the leachate will need to be conveyed to tanker trucks for transport to an offsite water treatment facility. A transfer pump is required to move water from the storage tank to the tanker truck loadout facility. The pump and forcemain were sized to convey approximately 250 gallons per minute (gpm), a rate commensurate with timely loading of the tanker trucks that have capacities equal to approximately 7,000 gallons. At 250 gpm, the tankers can be loaded quickly, depending on the operational requirements for moving leachate and making storage tank capacity available under high precipitation conditions and/or the condition when the storage tanks are at or near capacity. Storage and operations considerations are described in Section 5.9.2.4.

Combined sump pump and forcemain–The combined sump pump and forcemain must convey flow from the sump to the leachate storage tank. The flow criteria for this pump was set at approximately the same flow as the leachate transfer pump. This is based on the worst case scenario of the leachate transfer pump accidentally being left on when the tanker truck is filled, causing the full 250 gpm flow to overflow the truck, collect on the pad, and drain into the combined sump. Under less than maximum flow conditions, the pump would cycle when any leakage from other systems connected to the sump pump reached the level on control setting for the pump. In this case, the pump would cycle quickly to pump the small volume of the inner sump into the storage tank.

Crest pad building sump pump–A small sump pump is provided in the crest pad building to remove minor amounts of water in the sump from sampling activities or piping leaks. The nominal flow rate was chosen as a minimum of four gpm. The pump discharges into the main forcemain line to the storage tank or tanker truck load out facility.

The pump and forcemain piping systems were modeled using standard hydraulic analysis techniques. Actual pump curves for preliminary pump selections were input and the analyses conducted to determine the estimated run condition for the various operational conditions. For example, a pump was chosen for the LCRS high flow pump and forcemain system, and the analysis was run for the conditions of the pump conveying flow to the leachate storage tank and directly to the tanker truck load out facility. Different flow rates and system pressures resulted, based on the differences in the system curve for each flow path versus the pump curve characteristics. Pump cycle times were considered for the flow requirements and total removed volume. The manufacturer's recommendations for cycle times and other operating requirements, where applicable, were checked.

5.9.2.4 Leachate Collection Storage Analyses

The results of the leachate production analysis indicate a total of approximately 269,000 gallons of leachate must be removed from the IDF landfill within 24 hours after a peak storm event. A temporary storage tank for each cell was sized to store leachate generated by the associated cell. The leachate storage tank capacity is dependent on the flow rate of leachate into and out of the tank as well as a factor of safety.

The leachate production analysis indicates the worst case flow rate out of each cell into the associated tank would be 157 gpm (sum of the required flow rates of the high and low flow leachate pumps). The leachate transfer pump for each cell can fill a tanker truck at a maximum of 250 gpm; however, the limiting factor is how often a truck can be filled.

The calculation in Appendix C.8.c presents the method of determining the appropriate storage capacity of each leachate storage tank. The following leachate tanker truck loading activities were assumed:

- Tanker Capacity 7,000 gallons
- Number of tankers per cycle 1
- Hours per cycle (roundtrip) 2.4
- Hours per shift 8
- Shifts per day 1
- Leachate tank level prior to event 2 feet

The calculation indicates that each tank requires a maximum operational capacity of 375,000 gallons to maintain a safety factor of 1.5. The assumptions made in the calculation must be adhered to during operational activities to maintain the calculated safety factor.

5.10 Surface Stormwater

The surface stormwater analysis was done to determine the sizes of the surface stormwater facilities necessary for the IDF Phase I Critical Systems Design. The surface stormwater analysis is documented in detail in Appendix C.9.

The governing regulation is WAC 173-303-665(2) (c) and (d). This requires that the stormwater system be designed to prevent flow onto the active portion of the landfill during peak discharge from at least a 25-year storm. It also requires that the runoff management system be designed to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

The primary purpose of the proposed stormwater facilities is to prevent stormwater runoff from areas adjacent to the two Phase I cells from entering the cells during Phase I operation. This will be done by collecting, conveying, and safely discharging stormwater from areas outside of the two Phase I cells that would otherwise run into these cells.

The Department of Ecology has issued State Waste Discharge Permit Number ST 4510 for industrial stormwater discharges to the ground through engineered land disposal structures on the Hanford site (ST 4510, Ecology, 1999; DOE/RL97-67 Revision 3, January 2000). Since the design for this project does include facilities for collecting stormwater runoff and discharging it to the ground, the permit was reviewed to determine whether it applied to these stormwater discharges. To be covered by this permit, the stormwater must be considered an industrial discharge that is collected in an engineered structure and is then discharged to the ground through an engineered structure. A stormwater discharge is an industrial discharge if the stormwater has the potential to come into contact with an industrial activity or is collected within an area of industrial activity. The purpose of the stormwater facilities that have been designed for this project is to prevent the stormwater from areas outside of the Phase I landfill from entering the landfill area. Therefore, the stormwater collected by these facilities would probably not be considered industrial stormwater. To be an engineered structure for the collection of stormwater, the structure has to be an impervious surface that is directly associated with industrial activities. The stormwater collection facilities designed for this project do not have impervious surfaces. Therefore, permit ST 4510 does not apply to the stormwater system designed for this project.

Stormwater facilities were designed only for the operation stage of Phase I and not for interim or final closure conditions. Therefore, no stormwater facilities have been designed for stormwater runoff from the Phase I cells after construction of their interim closure or final closure. Stormwater needs for the construction, operation, and closure of future phases were not considered.

No stormwater collection and conveyance facilities were analyzed and/or designed for any of the roads and support facilities that will be constructed as part of this project. The roads will be gravel surfaced, and stormwater that does run off the roads into adjacent areas will infiltrate. The stormwater from the roofs of the buildings and the leachate tank covers will be ~~caught in gutters and~~ discharged to the ground surface ~~via down spouts~~. ~~The stormwater that falls on the leachate tanks will evaporate off the floating covers.~~

5.10.1 Existing Conditions

Under existing conditions, the area around the Phase I site slopes down gently from south to north at an average grade of approximately 0.5 percent.

The only area that may generate stormwater that can run into the Phase I excavation is the area that extends south from the excavation area to the crest of the sand dunes, located north of 1st Street (see drainage areas figure in Appendix C.9). This drainage area is moderately vegetated, primarily with large sage brush and grasses. The soils are generally sandy, with relatively high rates of infiltration. This area typically receives little precipitation. There is little to no runoff, and stormwater normally either infiltrates or is used by the vegetation. No existing drainage channels are apparent. The groundwater table is approximately 300 feet below the ground surface.

5.10.2 Proposed Stormwater Facilities

To prevent stormwater from the area south of the Phase I excavation from running overland into the excavation, a combination stormwater berm/ditch will be constructed south of the top of the south slope of the excavation. The south end of the excavation will be approximately 1,400 feet long, and the ground will be essentially flat. The berm/ditch will have a center high point and then slope down to the east and to the west (two discharge points). A berm will be constructed immediately south of the ditch. At the centerline of the excavation, the invert of the ditch will be at the existing ground surface, and the berm will form the south slope of the ditch. The ditch will be excavated, with a longitudinal slope of 0.5 percent to both the east and the west. This will be done in order to minimize the depth of the ditch at its east and west ends. Culverts will be installed at the east and west ditch ends to convey the flow under the access roads. The culverts will discharge into the east and west infiltration areas.

The base map does not show any areas where stormwater runoff from offsite areas may flow into the east or west boundaries of the Phase I excavation. However, if any offsite stormwater should flow toward these boundaries, the fill for the berm access road and the shine berm will prevent the stormwater from flowing into the excavation (see drainage areas figure in Appendix C.9). The intercepted stormwater will flow south along the toe of the fill and either infiltrate or flow overland to the north, away from the site at the north end of the berm access road.

The ground slopes away from the north end of the Phase I site, so there will be no offsite stormwater running toward the north Phase I boundary.

The Phase I liner will end north of the toe of the south slope of the Phase I excavation. In order to reduce potential leachate flows, a stormwater berm/ditch will be constructed just south of the south end of the liner. This berm/ditch will intercept and convey stormwater runoff from the unlined south slope and the unlined southern ends of the east and west slopes. The berm/ditch will be sloped to drain to the east. A stormwater pipe will convey the stormwater under the landing for the access ramp and will discharge to the excavation infiltration area. If this pipe ran straight from the ditch to the infiltration area, it would not have adequate cover. Therefore, a catch basin with a solid cover will be installed near the west end of the stormwater pipe. The invert of the pipe out of the catch basin will be lower than that of the pipe running into this catch basin. The stormwater pipe that will run from the catch basin to the excavation infiltration area will then have adequate cover. The excavation infiltration area will be excavated in the southeast corner of the excavation.

The south edge of the access ramp into the Phase I excavation and the south edge of the "flat" area at the bottom of the access ramp will serve as ditches. The access ramp will have a cross-slope of 2 percent down to the south. The "flat" area at the bottom of the access ramp will have a slope down to the south that varies between 1 and 3 percent. Adjacent to each of these will be the south slope of the excavation. Construction of a full V-shaped ditch along the south side of the access ramp and the "flat" area was considered. This idea was rejected because it would result in a larger excavation with the top of the Phase I south slope moved further south.

The stormwater facilities are shown on the Phase I Grading and Drainage Plan drawing (Drawing H-2-830830).

Stormwater runoff from the north, east, and west lined slopes of Phase I will run into the bottom lined area and will become leachate.

There are no provisions in the design of the Phase I critical systems to divert clean runoff from these side slopes and discharge it to the surface water system instead of the leachate system at this time. However, a rain curtain or other approach to reduce the amount of clean runoff from the lined area that enters the leachate system may be considered in the future.

5.10.3 Analysis

The surface stormwater analysis is documented in Appendix C.9 and is summarized below. Stormwater runoff flows were estimated for a 24-hour, 25-year design event, using the Soil Conservation Service curve number methodology as documented in *Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture, June 1986) and the Hydraulic Engineering Cirular-1 (HEC-1) computer program (*Flood Hydrograph Package (HEC-1)*, U.S. Army Corps of Engineers, Hydrologic Engineering Center, revised June 1988). The precipitation data used was based on information from the *Hanford Site Climatological Data Summary 2001* (Pacific Northwest National Laboratory, May 2002). The ground at the project site is periodically frozen during the winter months, when the most precipitation falls. Therefore, it was assumed that the ground was frozen for the runoff flow calculations.

The peak flows (calculated using the HEC-1 model) were checked for reasonableness. The tabular and graphical methods in TR 55 were used to estimate peak 25-year flows for each of the drainage areas modeled in HEC-1. The results confirmed the reasonableness of the peak flows calculated by HEC-1.

The berm/ditches were designed to convey the peak 25-year flow with a minimum freeboard of one foot.

The infiltration areas were sized based on containing and infiltrating the runoff from the 24-hour, 25-year design event, without causing the water surface to extend above the upstream end of the culvert or stormwater pipe that will discharge to the infiltration area. No specific infiltration data have been collected at the IDF project site. However, infiltration rates have been determined for use at the Waste Treatment Plant (*Geotechnical Report Supplement No. 1*, Shannon and Wilson, April 2001). These infiltration rates were used in sizing each of the infiltration areas.

The culverts and stormwater pipes were designed to convey the peak 25-year flow with a maximum headwater to a diameter ratio of 1.25. Both inlet and outlet flow conditions were analyzed. The starting water surface for the outlet flow condition calculations were the maximum water surface elevation estimated for the associated infiltration area for the 24-hour, 25-year design event.

5.11 Action Leakage Rate (ALR)

5.11.1 LDS ALR

The ALR is defined in WAC 173-303-665(8) and the Final Rule (EPA 1992a, 40 CFR Part 264.222) as the "maximum design flow rate that the leak detection system…can remove without the fluid head on the bottom liner exceeding 1 foot". This calculation was performed to determine the ALR for the IDF lining system. The IDF consists of two cells, each with an area of approximately 8.5 acres.

In addition to determining the ALR, an estimate of actual leakage rate through the proposed primary bottom lining system is provided as a comparison to the calculated ALR. HELP modeling for the side slope indicates negligible head build-up on the side slopes (see Section 5.8), thus an estimation of the actual leakage rate was determined for the bottom primary lining system only.

EPA provides a formula (based on Darcy's Law for calculating this flow capacity), assuming that it originates from a single hole in the primary liner (EPA, 1992b). Calculations presented in Appendix C.10 provide details of the method of analysis and input data. The ALR calculations are dependent on the transmissivity value for the CDN. A value of 3 x 10-5 m2/sec was used in the ALR analysis (equivalent to the value required by WAC and EPA regulations for the LDS, Section 5.7.2). Calculations in Appendix C.6.b2 provide justification for the transmissivity used in the ALR analyses.

The results of the analyses indicate the ALR for each IDF cell is 206 gallons per acre per day (gpad) or approximately 1,800 gallons per day per cell. This ALR includes a factor of safety of 2 in accordance with EPA guidelines (EPA, 1992b).

It is also much lower than the capacity of the pump that removes liquid from the LDS. The estimated actual leakage rate for the composite primary lining system is 0.06 gpad (small defect) to 0.08 gpad (larger defect) for a composite liner with good intimate contact, and 0.3 gpad (small) to 0.4 gpad (large) for poor contact. Detailed calculations for both rates are presented in Appendix C.10.

The proposed primary composite lining system has a much lower estimated leakage rate than the ALR. This demonstrates the benefit of the GCL that is included in the primary bottom lining system, to provide a composite lining system and minimize actual leakage rate through the bottom primary lining system.

5.12 Building Systems Analyses

5.12.1 Geotechnical Design Parameters

The key geotechnical parameters and analyses for structural design of the supporting facilities for the Hanford IDF included the following:

- Bearing Capacity
- Settlement
- Modulus of Subgrade Reaction
- Earth Pressures
- UBC Seismic Soil Parameters

The methodologies, input data, and results for each of these categories of analysis are presented in detail in Appendix C.11.A.

5.12.2 Structural

5.12.2.1 Crest Pad Building Foundation Analysis, Pipe Bracing and Winch

The crest pad building foundation was analyzed as a concrete slab on an elastic foundation. The foundation was modeled with springs to model the vertical sub-grade reaction. The value of the vertical sub-grade reaction was provided by the geotechnical engineer. The applied loads and load combinations were input into Visual Analysis (version 4.0), a finite element program. The finite element analyses results include elastic settlement, moments, and shears values of the concrete slab. The results were then used to design slab depth and reinforcing.

Load reactions from the pre-engineered metal building were estimated using hand calculations and applied onto the concrete slab at the corners of the slab. It is a reasonable assumption that the frame loads from the pre-engineered metal building will only occur at the corner of the building, since the size of the building will not require any intermediate framing.

Loads and load combinations were used as required by TFC-ENG-STD-06, REV A. Performance category, PC-1 was used as specified and applied as applicable for both wind, seismic, and load combinations requirements.

In summary, the analyses results showed that an 8-inch thick slab sufficed with #5 reinforcing at 12-inch centers. The analyses results also showed that a 1 foot-10 inch edge thickening around the perimeter of the building would be sufficient. More detailed accounting of the analyses is presented in Appendix C.11.b1.

The pipe bracing and support for the small diameter PVC (polyvinyl chloride) piping included both gravity as well as lateral load resistance, due to a seismic event. The governing piping support is assumed a 6-foot-tall cantilever support, with the piping load and 50 pounds of lateral load applied to the top of the support. The 50 pound lateral load was used in lieu of the calculated seismic load because the calculated seismic load was only 19 pounds. Using a 50 pound lateral load gives the pipe support system greater rigidity. Detailed calculations of the pipe supports are included in Appendix C.11.b2.

The winch support was analyzed as a vertical cantilever that supports the winch and resists a total lateral load of 400 pounds.

A 400 pound lateral load was used since the entire gravity load of the pump and the hoses adds up to this weight. Therefore, using 400 pounds in the horizontal direction is conservative. Detailed calculations of the winch support are given in Appendix C.11.b3.

5.12.2.2 Leachate Transfer Building Foundation Analysis

As the leachate transfer building foundation is considered as a slab–on-grade, only hand calculations were performed. Foundation soil reactions were considered to be distributed linearly, then soil pressure distributions were applied to the concrete to calculated the moment and shear values for design of the concrete slab and reinforcing steel.

Load reactions from the pre-engineered metal building were estimated using hand calculations and applied onto the concrete slab along the perimeter of the slab.

Loads and load combinations were used as required by TFC-ENG-STD-06, REV A. Performance category, PC-1 was used as specified and applied as applicable for both wind, seismic, and load combinations requirements.

In summary, the analyses results showed that the 2-foot-6 inch-thick slab with #6 bars at 12-inch centers will suffice and appears to be overdesigned. The 2-foot-6-inch thickness is not based on concrete strength requirements but more for frost depth cover, simplifying the ground forming, and reinforcing bending requirements. Detailed calculations of the analyses are presented in Appendix C.11.c.

5.12.2.3 Leachate Tank Foundation Analysis

The leachate tank foundation is considered to be a concrete ringwall, per AWWA D103-97. The tank gravity loads, including both water load and tank dead loads, were considered in the design of the ringwall.

AWWA D103-97, Factory-Coated Bolted Steel Tanks for Water Storage is not listed in the TFC-ENG-STD-06, REV A. AWWA D100-96, Welded Steel Tanks for Water Storage, is listed; however, this standard does not apply, since the tank will be a bolted steel tank. Therefore, the tank will be designed per AWWA D103-97, Factory-Coated Bolted Steel Tanks for Water Storage.

The analysis of the concrete ringwall and reinforcing is based on the hoop tension on the ringwall from the surcharge of the liquid weight on the soil within the ringwall. In summary, a 4-foot-6-inch-deep by 1-foot-6-inch width ringwall with #7 at 12-inch-longitudinal reinforcing on each face of the ringwall will suffice. Detailed calculations of the analyses are presented in Appendix C.11.d.

5.12.2.4 Truck Loading Station Foundation Analysis and Leachate Loading

The Truck Loading Station foundation was analyzed as a concrete slab on an elastic foundation. The foundation was modeled with springs to model the vertical subgrade reaction. The value of the vertical subgrade reaction was provided by the geotechnical engineer. The applied loads and load combinations were input into Visual Analysis (version 4.0), a finite element program. The finite element analyses results include elastic settlement, moments, and shears values of the concrete slab. The results were then used to design slab depth and reinforcing.

Loads and load combinations were used as required by TFC-ENG-STD-06, REV A. As required, AASHTO HB-16 loading was used with an HS 20-44 load wheel pattern. For maximum axle load, 40,000 pounds was used instead of 32,000 pounds as required per HS 20-44. An impact factor was also applied as required by AASHTO HB-16.

The wheel pattern loading was arranged in three positions on the slab to yield the maximum moments and shears. Supporting calculations and further discussions are presented in Appendix C.11.e1.

The leachate loading support was analyzed as a post with a horizontal boom attached near the top of the post. The design load included the dead weight of the post, boom, and piping full of water. Wind loads were analyzed per ASCE 7-98.

In addition, the lateral load was compared with a 300-pound point load hanging vertically at the end of the boom. The lateral wind load governed for overall overturning at the base of the post; however, the 300-pound point load governed for the boom attachment to the post.

In summary, a 10-inch by 10-inch tube for the post, with a 6-inch by 6-inch tube as the horizontal boom welded to the post will suffice. The geotechnical engineer has verified that a 5-foot-6-inch-deep and 3-foot-diameter concrete encasement around the post will be sufficient for strength and stability. Supporting calculations and further discussions are presented Appendix C.11.e2.

5.12.2.5 Leachate Tank Dome Cover Structural Analysis

Structural components for the dome covers over leachate tanks 219A201 and 219E201 include the steel supports, concrete foundations, and the aluminum fabricated dome covers, which are procured and delivered as a pre-engineered and pre-constructed structures. The leachate tanks do not have the required structural strength to support the fabricated domes, therefore, the tank dome covers are supported by support columns (see H-2-837973, Sheets 1-3 in Appendix 4A3).

The structural analysis for the leachate tank domes steel supports and foundations was performed in CHPRC-04065, *Tank Cover Support Framing and Foundation Calculations*. The structural analysis for the fabricated leachate tank domes will be performed by dome vendor and will include a complete structural design calculation stamped by a Professional Engineer registered in Washington State and compliant with PRC-STD-EN-40259, *Engineering Calculations* and satisfying computer software verification and validation requirements in accordance with PRC-PRO-IRM-309, *Controlled Software Management*.

5.12.2.6 Leachate Transfer Pipeline Loading Calculation

A calculation to confirm that the leachate transfer pipline and leak detection sumps are structuraly capable for the designed soil pressure, leachate fluid pressure, traffic, and surcharge loads was performed and is documented in CHPRC-03955, Leachate Pipe Loading Calculation.

5.12.3 Mechanical/Heating, ventilating, and air conditioning (HVAC)

5.12.3.1 Crest Pad and Leachate Transfer Building

Heating, ventilating, and air conditioning (HVAC) capacities were calculated for the crest pad and leachate transfer buildings. The temperature within the buildings must be controlled within a range to prevent freezing fluids in piping or overheating electronic devices. The HVAC components for the buildings were selected based on the criteria and calculations provided in Appendix C.11.f and C.11.g.

5.12.4 Electrical/I&C

This section introduces and summarizes the results of detailed electrical engineering calculations included in Appendix C.11.h.

- IDF leachate collection and handling crest pad facilities (two each)
- IDF leachate storage tank and leachate transfer facilities (two each)
- IDF truck loading facilities (two each)

5.12.4.1 Building Power Supply

Open Items

The Phase I Critical Systems 80% IDF design documents do not identify the following open items:

- Exact location of primary 13.8 kV, 3-phase tie-in
- Exact value of available primary short circuit current at primary tie-in location
- Exact length of primary extension
- Exact location, size, and impedance of utility step-down 13.8 kV – 480/277V three, phase, 4-wire pad mounted transformer(s)

These items are scheduled to be addressed during the next IDF Phase I Non-Critical design.

Assumptions

The following assumptions were made in order to complete the 80% engineering analysis.

- Assume electrical service gear inside each Cell 1 and Cell 2 crest pad building to be powered by separate pad mounted utility transformers.
- Assume pad mounted utility transformers to be rated 75 kVA and installed within 100 feet of respective Cell 1 and Cell 2 crest pad buildings.
- Assume each pad mounted utility transformer to be radial fed from a common 13.8 kV primary feeder.
- Assume each Cell 1 and Cell 2 leachate transfer building to be powered from electrical service gear, located inside respective crest pad buildings.
- Assume available short circuit at primary side of pad mounted utility transformer(s) to be 100 MVA with an (X/R) ratio equal to 8.
- Assume impedance of 75 kVA pad mounted utility transformer to be 3.2%Z, 2.42%IR, and 2.10%IX.
- Assume power factor and efficiency for all pump motors to be 85 percent and 82 percent, respectively.
- Assume 25 foot candles of lighting levels to be required for interior of each building.

- Assumptions will be reviewed and addressed during the next IDF Phase I Non-Critical design.

Method of Analysis

- Branch circuit, feeder and service calculations in accordance with NEC Code (2002).
- Short circuit analysis (per unit) in accordance with IEEE-Red Book, Standard 141 (1993).
- Grounding electrode analysis in accordance with IEEE-Green Book, Standard 142 (1991).
- Computer analysis by SKM PTW 32 (Power Tools for Windows, 2003).
- Building interior lighting zonal cavity method in accordance with Integrated Engineering Software, Inc. (IES) *Lighting Handbook* (2000).

Analysis Performed Includes

- Calculate and size service, feeder, and branch circuits, based upon demand and design loads.
- Calculate and size equipment, equipment bus amperage, protective devices, and motor overloads, based upon demand and design loads.
- Calculate and size power feeders and branch circuit wiring, based upon demand and design loads.
- Calculate short circuit ratings for equipment.
- Calculate feeder and branch circuit voltage drop, and power factor.
- Calculate building lighting system requirements.

Voltage Drop

Load flow steady state voltage drop calculations for all feeders were based upon an equipment 85 percent power factor. Wire size were calculated and selected so that circuits do not exceed total voltage drop from the source bus to the point of utilization, including feeders and branch circuits:

Service and sub feeders	2 percent	Heat trace from panels	1 percent
Lighting from panels	1 percent	Receptacles from panels	1 percent
Motors from motor control center (MCC)	1 percent	Instrumentation from panels	1 percent

Feeder and Equipment Sizing

Service, feeder, branch circuit conductor ampacity, and protection devices ratings are based upon applicable sections of the NEC (2002) including:

- Lighting Loads per Article 220: Lighting
- Receptacle Loads per Article 220.13: Non-dwelling Units
- Continuous Loads per Article 230: Service
- Motor Loads per Article 220:14 and 430: Motors
- Air Condition Load per Article 440.6: Refrigerant Motor Compressor
- Heat Loads per Article 200.15: Fixed Electric Space Heating
- Non-Coincident Loads per Article 220.21: Non-coincidental Loads
- Heat Trace per Article 427: Fixed Electric Heating Equipment for Pipelines and Vessels

Load Factors

The following table summarizes load factors applied for various equipment in accordance with appropriate sections of the NEC (2002), while determining demand and design load analysis:

Table 5-4. Building Power Supply Load Factors

Item	Panel and Service Load Analysis	Comment
Heater Loads*	100 percent full load amperage (FLA)	Branch circuit sized to 125 percent of FLA

Motor Loads	Sum of motor load (FLA) + 25 percent of largest motor (FLA)	Branch circuit sized to 125 percent of FLA
Receptacles	180 VA /outlet	Non-Continuous Load
Lighting	2 watts/sq.-ft or total connected (FLA), whichever is larger	Continuous Load
Cooling Loads*	100 percent FLA	Branch circuit sized to 125 percent of FLA
Demand Factors	**Demand Factor Percent**	
First 10 kVA	Non-Dwelling Receptacles	100 percent
Remainder over 10kVA	Non-Dwelling Receptacles	50 percent
Non-continuous Load		100 percent
Continuous Loads		125 percent
*Note: The largest of the non-coincidental heat and cooling loads are used for service sizing.		

Table 5-5. Input Data Typical for Cell 1 and Cell 2

Description	Ratings	Comments
Pump 219(Y)-LH-P-202	1/2 HP @ 480V, 3-phase	Coincidental load
Pump 219(Y)-LH-P-203	7.5 HP @ 480V, 3-phase	Coincidental load
Pump 219(Y)-LH-P-204	1/2 HP @ 480V, 3-phase	Coincidental load
Pump 219(Y)-LH-P-205	1/3 HP @ 480V, 3-phase	Coincidental load
Pump 219(Y)-LH-P-207	3 HP @ 480V, 3-phase	Coincidental load
Pump 219(Y)1-LH-P-302	3 HP @ 480V, 3-phase	Coincidental load
Heater 219(Y)-LH-UH-001	3.3 kW @ 480V, 3-phase	Non-coincidental and continuous load*
Heater 219(Y)1-LH-UH-002	3.3 kW @ 480V, 3-phase	Non-coincidental and continuous load*
Air Condition 219(Y)-LH-AC-001	2.04 kVA @ 208V, 1-phase	Non-coincidental load
Air Condition 219(Y)1-LH-AC-002	.96 kVA @ 208V, 1-phase	Non-coincidental load
Control Panel 219(Y)-LH-CP-001	1.5 kVA @ 120V, L-N	Continuous load
Bldg. 219(Y) Lighting	71 kVA @ 120V, L-N	Continuous load
Bldg. 219(Y)1 Lighting	29 kVA @ 120V, L-N	Continuous load
Heat Trace 219(Y)201-LH-HT-001	77 kW @ 120V, L-N	Continuous load
Heat Trace 219(Y)201-LH-HT-002	77 kW @ 120V, L-N	Continuous load
Heat Trace 219(Y)1-LH-HT-003	77 kW @ 120V, L-N	Continuous load
Bldg. 219(Y) Receptacles	720 kVA @ 120V, L-N	180VA/ outlet
Bldg. 219(Y)1 Receptacles	360 kVA @ 120V, L-N	180VA/ outlet

Note: (Y) = A,E
Cell 1 (A), Cell 2 (E)
Heater Load is greater than AC load.

Table 5-6. Building Power Supply Results/Conclusions

Description	Ratings
Bldg. 219(X) connected load @ 219(X)-LH-MCC-001	23 kVA connected – 26 kVA design for each crest pad building.
Bldg. 219(X) main service breaker size @ 219(X)-LH-MCC-001	100 amps
Bldg. 219(X) main service feeder to 219(x)-LH-MCC-001	3#1 TW, 1#1 TW (N)
Bldg. 219(X) service transformer	75 kVA, 480V, 3-phase, 4-wire
Bldg. 219(X)1 transfer bldg. feeder breaker size	50 amps
Bldg. 219(X)1 transfer bldg. feeder size	3#4 TW, 1#8 G
219(x)-LH-MCC-001 short circuit available	2,484 amps symmetrical
219(x)1-LH-SW-002 short circuit available	1,632 amps symmetrical
219(x)-LH-LP-001 short circuit available	1,177 amps symmetrical
219(x)1-LH-LP-002 short circuit available	1,068 amps symmetrical
219(X) –LH-LP-001 lighting panel rating	60 amps
219(X)1-LH-LP-002 lighting panel rating	60 amps
219(X)-LH-T-001 lighting panel transformer rating	15 kVA
219(X)1-LH-T-002 lighting panel transformer rating	15 kVA
219(X)-LH-P-203 LCRS high flow pump motor feeder size	3#12 TW, 1#12 G
219(X)-LH-P-202 LCRS low flow pump motor feeder size	3#12 TW, 1#12 G
219(X)-LH-P-204 LDS pump motor feeder size	3#12 TW, 1#12 G
219(X)-LH-P-205 sump pump motor feeder size	3#12 TW, 1#12 G
219(X)1-LH-P-302 transfer pump motor feeder size	3#12 TW, 1#12 G
219(X)-LH-P-207 combined sump pump motor feeder size	3#12 TW, 1#12 G
219(X)-LH-UH-001 unit heater feeder size	3#12 TW, 1#12 G
219(X)1-LH-UH-002 unit heater feeder size	3#12 TW, 1#12 G
219(X)-LH-AC-001 air condition feeder size	3#10 TW, 1#10 G
219(X)1-LH-AC-002 air condition feeder size	3#12 TW, 1#12 G
219(X)-LH-MD-001 motor damper feeder size	2#12 TW, 1#12 G
219(X)1-LH-MD-002 motor damper feeder size	2#12 TW, 1#12 G
219(Y)201-LH-HT-001 leachate storage tank heat trace feeder size	2#10 TW, 1#10 G
219(Y)201-LH-HT-002 leachate storage tank heat trace feeder size	2#10 TW, 1#10 G
219(Y)1-LH-HT-003 truck loading station heat trace feeder size	2#10 TW, 1#10 G
219(X)-LH-CP-001 main control panel feeder size	2#10 TW, 1#10 G
Note: (X) = A,E	

Recommendations

Building Power Supply

- Provide separate power distribution equipment (pad mount utility transformer, secondary service, and power distribution gear) for Cell 1 and Cell 2 in order to maximize redundancy.

- Install service rated motor control center inside each crest pad building for providing service entrance, branch, and sub-feeder distribution capability, and complete motor control for various process control systems.
- Power lighting, receptacle, and facility loads from 3-phase, 4-wire lighting panel installed in each building.
- Power instrumentation from surge protected distribution center mounted inside facility control panel.
- Ground Electrode System.
- Provide and install ground electrode system for service and each separately derived system that incorporates both ground ring, ground rod, and concrete encased building rebar.
- Provide ground bus inside Process Instrumentation and Control Systems (PICS) control panels and bond to common ground electrode system.
- Bond non-current carrying metallic structure to ground electrode system that has the potential of becoming energized by attached electrical devices such as metallic conduit systems, enclosures, storage tank structures, building metal framing and siding, and above grade metallic process equipment.

5.12.4.2 Crest Pad Building Lighting

Building lighting systems were based upon I.E.S Zonal Cavity method in order to maintain an average 25-foot-candle level for process interior of each building.

Note: Interior lighting levels are based upon *IES Lighting Handbook Indoor Industrial Areas Recommended Illuminance Levels* for interior activities inside work spaces where visual tasks of medium to large contrast are to be performed on occasional basis.

Note: Exterior entrance lighting levels are based upon *IES Lighting Handbook Outdoor Site/Area Recommended Illuminance Levels* for building exterior entrances frequently visited locations.

Open Items

None

Assumptions

The following assumptions were made when analyzing building lighting.

Reflectance for unfinished rooms:

Ceilings	50 percent reflectance
Walls	50 percent reflectance
Floors	20 percent reflectance

Maintenance factor (light loss factor), interior lighting:

Incandescent lighting	.80
Fluorescent lighting	.61
HPS lighting	.70

Maintenance factor (light loss factor), exterior lighting:

HPS lighting	.70

Inputs

Crest pad buildings are unfinished industrial buildings with interior dimensions of:

Room name: Cell 1 crest pad building	Ceiling height: 11 feet
Fixture type: fluorescent two-lamp	Mount height: 9 feet

Room size: width 16 feet and length 21 feet	Area: 336 square feet

Recommendations

- Provide fluorescent low temperature starting wrap-around industrial fixtures for interior lighting of buildings.
- Use two lamps in six fixtures for 25-foot candles minimum.
- Install low pressure sodium fixture at front entrance on north exterior wall.

5.12.4.3 Leachate Transfer Building Lighting

Building lighting system was based upon I.E.S Zonal Cavity method in order to maintain an average 25-foot-candle level for process interior of each building.

Note: Interior lighting levels are based upon *IES Lighting Handbook Indoor Industrial Areas Recommended Illuminance Levels* for interior activities inside work spaces where visual tasks of medium to large contrast are to be performed on occasional basis.

Note: Exterior entrance lighting levels are based upon *IES Lighting Handbook Outdoor Site/Area Recommended Illuminance Levels* for building exterior entrances frequently visited locations.

Open Items

None

Assumptions

The following assumptions were made when analyzing building lighting.

Reflectance for unfinished rooms:

Ceilings	50 percent reflectance
Walls	50 percent reflectance
Floors	20 percent reflectance

Maintenance factor (light loss factor), interior lighting:

Incandescent lighting	.80
Fluorescent lighting	.61
HPS lighting	.70

Maintenance factor (light loss factor), exterior lighting

HPS lighting	.70

Inputs

Crest pad buildings are unfinished industrial buildings with interior dimensions of:

Room name: leachate transfer building	Ceiling height: eight feet
Fixture type: fluorescent two-lamp	Mount height: eight feet
Room size: width 10 feet and length 10 feet	Area: 100 square feet

Recommendations

- Provide fluorescent low-temperature starting wrap-around industrial fixtures for interior lighting of buildings.
- Use two lamps in two fixtures for 25-foot candles minimum.
- Install low pressure sodium fixture at front entrance on north exterior wall and low pressure sodium on south exterior wall.

5.12.4.4 Uninterrupted Power Supply (UPS) Sizing

Uninterruptible power is provided and sized to provide 25 minutes minimum of continuous backup power to the PICS programmable logic controller (PLC), operator interface unit (OIU), and local area network communication equipment.

In the event of a power failure, UPS will maintain communication with remote monitoring sites (future) and insure safe shutdown of power sensitive PICS equipment.

Open Items

None

Assumptions

None

Table 5-7. Input Data Typical for Cell 1 and Cell 2 Control Panel Loads

Description	Ratings	Comments
PLC Power Supply	180 VA	Continuous load
OIU Power Supply	60 VA	Continuous load
Ethernet Switch Power Supply	44 VA	Continuous load
Total *1.25	**355 VA**	

Recommendations

Table 5-8. Fortress Runtimes for Typical Applications in Minutes

Load (VA)	50	100	200	300	400	500	600	750	900	1050	1250	1425	1800	2250
0520-1050U	200	125	63	42	31	24	19	14	11	9.5	-	-	-	-
0520-0750U	132	75	38	26	19	14	11	8.5	-	-	-	-	-	-

Provide 1050 VA 120 Volt- 120 Volt UPS to achieve the 25 minutes minimum of continuous backup, power in the event of a power failure. Additional capacity will compensate for battery cycling deprivation.

5.13 Civil Grading

5.13.1 Waste Volume, Cut/Fill and Stockpile Requirement Calculations

The IDF is designed to provide the waste volume requirements identified by CH2M HILL. Those requirements consist of an ultimate landfill capacity for 1,177,110 cubic yards of waste and a Phase I capacity of 213,515 cubic yards of waste.

The IDF is also designed to balance the cut and fill volumes of the project. The ultimate landfill layout on the project site provides this balance. The volume balance includes excavated material, which will be used for the construction of the closure cap. Since the closure cap will be selected and designed in the future, assumptions for the cap layout and construction were made.

With a phased construction approach planned for IDF and the fact that the material balance includes backfill to construct a closure cap for the ultimate landfill, a substantial volume of material will be stored in stockpiles at the completion of construction of Phase I landfill. The Phase I landfill design volumes for subgrade cut, admix liner, drain gravel, and operations layer material were calculated using a 3-D AutoCAD model of the landfill. These volumes were used to identify the stockpile requirements to store material once Phase I construction is complete.

Potential stockpile locations are identified on the project site plan. Calculations of these volumes are included in Appendix C.12.a. Calculations in Appendix C.12.a also present confirmation of the available waste volume and cut/fill balance.

5.13.2 Phase I Access Road and Ramp Cross Section Design

Two cross sections using granular material for base and top course were designed for the Phase I landfill access roads and the access ramp into the landfill. The design reflects the estimated wheel loads and vehicles to use the facility daily. Calculations presenting the development of these cross sections are included in Appendix C.12.b.

6.0 FACILITY DESIGN AND CONSTRUCTION

6.1 Facility Layout

6.1.1 Location

The IDF will be located approximately 1,400 feet east of Baltimore Avenue and directly north of 1st Street in the 200 East Area of the Hanford Site. Phase I of the IDF landfill will measure approximately 800 feet by 1,500 feet, with its north-south axis being the shorter dimension. Leachate handling facilities will be located immediately north of the Phase I cells. The excavated depth to subgrade (not including sump depressions) will range from approximately 44 to 51 feet. Excavation will be deepest at the landfill's north end, near the sumps and along the centerline of each cell. It will be shallowest at the southwest and southeast corners of Cells 1 and 2, respectively. Stockpile locations for excavated materials will be situated east and southeast of the Phase I landfill excavation. At the completion of Phase I construction, exposed surfaces of the stockpiles and disturbed areas will be covered with a layer of topsoil, then seeded and mulched. A borrow area of soil to supplement admix preparation is located south of the Phase I excavation location.

6.1.2 Access Roads and Ramps

For access to Phase I of the IDF, waste hauler and operations vehicles will follow an access road and travel north from 1st Street. All roads and ramps at the Phase I IDF site will be constructed with crushed surfacing material for the base and top courses. The access road from 1st Street will be aligned with the landfill's west berm access road. The road will also follow the alignment of the west access berm road for the future IDF cells.

The access road will lead north, approximately 1,000 feet from 1st Street to where it widens into an intersection. At this location, a turn to the east will lead down a 5 percent grade, 800-foot-long access ramp into the Phase I landfill. The access ramp slope was selected to allow use by both waste haul trucks and the melter transporter. The grade of the access road from 1st Street was also limited to a maximum of five percent for this same reason. The access ramp into the landfill and the access road from 1st Street to the intersection area will be both 30 feet wide.

At that base of the ramp into the landfill, there will be adequate room for waste haul vehicles to turn and move the waste into the cells. The liner system will be installed to extend approximately 50 feet south beyond the estimated toe of slope of Phase I waste placement. This extension will allow waste haul vehicles to be staged or unloaded over a lined area.

At the access road intersection, continuing north will lead up a short ramp and onto the berm access road. The berm access road will be 20 feet wide on the east and west sides of the landfill. The road will widen to 30 feet at the northwest and northeast corners of the landfill and along the landfill's north side.

The wider road in these areas will allow operations vehicles to traverse around road corners and the crest pad buildings.

The access road will continue from the northwest corner of the berm access road to the Cell 1 and Cell 2 leachate storage tank facilities. A cul-de-sac area will be provided just east of the Cell 2 leachate facilities to provide a turnaround area for operations vehicles and leachate tanker trucks.

A road will also be provided to allow operation vehicles to travel south between the leachate facilities and onto the berm access road at the centerline of IDF landfill.

Future projects are being planned to upgrade the 1st Street pavement and construct an operation building north of the IDF landfill. It is anticipated that these facilities will connect to access roads designed for the Phase I landfill.

Related to permanent access roads and their use, the construction contractor will be required by the project general requirements to submit a plan, which details their use during construction. This plan will address locations and limits of stripping/grubbing, construction haul roads, stockpile/borrow areas and other construction staging areas.

6.1.3 Survey Grids

Survey grids for this project use the Washington State Plane coordinate system (South Zone–feet, NAD83 Lambert Projection). Contours are based on 200 Area topographic mapping database, provided by Hanford HGIS Department and dated 1991. A 1-foot contour interval was used on the design drawings.

As part of the Phase I landfill design, construction control points were developed for landfill and sump subgrades as well as for the anchor trenches, stormwater facilities, and the finished grades for all roads and ramps. North and east coordinates and elevations for these points are included in a survey control table on Drawing H-2-830829, Sheet 2 of 2. The control points and lines between them will provide a location grid that will allow construction of the subgrade, liner system, operations layer, and the finished grades for the IDF.

6.2 Landfill Geometry

6.2.1 Waste Volumes and Types

6.2.1.1 Volume

Two key design criteria were provided by CH2M HILL concerning waste volumes:

- Phase I of the IDF should be designed to receive a waste volume of 213,515 cubic yards, which is equal to163,250 cubic meters. CH2M HILL identified the waste volume for placement in all phases of IDF (ultimate landfill size) as 1,177,110 cubic yards, or 900,000 cubic meters.
- Both the Phase I landfill and the ultimate landfill volumes should be sized for an air space, which includes 1.5 cubic yards of clean fill for every cubic yard of waste.
- Using these criteria, Phase I was designed to provide air space for placement of 533,620 cubic yards of waste and clean fill.

6.2.1.2 Waste Types

(Note: The disposal of MLLW other than ILAW, DBVS Waste, and IDF generated waste is not permitted at this time by this permit.)

The IDF will receive waste types including ILAW, DBVS Waste, and LLW. These wastes include both contact and remote-handled wastes. As identified in the project kickoff meetings by CH2M HILL, the waste volumes (in cubic yards) are estimated to include the following:

Waste Type	Phase I	All Phases
ILAW	50,025	753,350
MLLW	57.550	146,485
LLW	105,940	277,275
Total	**213,515**	**1,177,110**

These volumes are based on waste forecast information provided by Fluor Hanford, Inc. (FH). The waste volume forecasts are updated by Hanford Site contractors on a regular basis. The volumes above represent an average between the FH 2002 Forecast and the FH 1999 (with EIS) Forecast. Short descriptions of the waste types are given below:

Immobilized Low-Activity Waste (ILAW)–The ILAW packages are stainless steel cylinders that have been filled with vitrified low-activity waste (physically similar to glass), sealed, and cooled. The source of these waste cylinders is the Waste Treatment and Immobilization Plant. The packages are 7.5 feet in height and 4 feet in diameter, and could weigh up to 22,050 pounds each.

Contact-Handled Mixed Low-Level Waste (CH MLLW)–This waste has a dose rate equal to or less than 200 mrem/h and contains radioactivity not classified as high-level waste, spent nuclear fuel or transuranic (TRU) waste (TRU is defined as concentrations of transuranic radionuclides greater than or equal to 100nCi/g of the waste matrix). The waste is also defined as dangerous (hazardous) waste in WAC 173-303.

Remote-Handled MLLW – This waste has a dose rate greater than 200 mrem/h and contains radioactivity not classified as high-level waste, spent nuclear fuel, or TRU waste. The waste is also defined as dangerous (hazardous) waste in WAC 173-303.

Low-Level Waste Category I (LLW I)–This waste contains radioactivity not classified as high-level waste, spent nuclear fuel, or TRU waste. The waste also meets the radionuclide limits for category I waste, defined in the *Hanford Site Solid Waste Acceptance Criteria* (RH, 1998). This waste may be comprised of either contact- or remote-handled waste considered low-activity waste with very low concentrations of long-lived radionuclides. This waste is not a dangerous (hazardous) waste as defined in WAC 173-303.

Low-Level Waste Category III (LLW III)–This waste contains radioactivity not classified as high-level waste, spent nuclear fuel, or TRU waste. The waste also exceeds the radionuclide limits for category I waste and meets the category III limits, defined in the *Hanford Site Solid Waste Acceptance Criteria* (FH, 1998). This waste may be comprised of either contact- or remote-handled waste considered moderate- to high-activity waste with low to moderate concentrations of long-lived radionuclides, in stabilized form that minimizes subsidence for a period of 1,000 years. This waste is not a dangerous (hazardous) waste as defined in WAC 173-303.

Remote-Handled LLW – This waste has a dose rate greater than 200 mrem/h and contains radioactivity not classified as high-level waste, spent nuclear fuel, or TRU waste. This waste is not a dangerous (hazardous) waste as defined in WAC 173-303.

6.2.2 Landfill Phases and Dimensions

The IDF will be a single, expandable RCRA Subtitle C disposal facility that provides ultimate capacity for 1,177,110 cubic yards (900,000 cubic meters) of waste. The facility is currently anticipated to be constructed in four phases. Phase I will have two cells. Only Phase I is being permitted at this time. Each cell has a floor width of approximately 543 feet and a lined floor length of 360 feet. The total floor width of the IDF will be 1,085 feet. Side slopes of the landfill will be 3:1 (horizontal: vertical). At the south end of the Phase I cells, there will be a stormwater berm/ditch system with an infiltration area. The south side of IDF will be unlined for Phase I.

IDF will be expanded by relocation of the landfill's unlined south slope from earlier phases and installation of liner system and operations layer. When expanded to its final configuration, the floor of IDF will be 1,385 feet long, measured along its north-south axis.

6.2.2.1 Depth and Length

The landfill depth for all phases of the IDF is set to accommodate four layers of ILAW waste packages, placed on end, and each layer will be covered with 3.3 feet of clean soil. In some cases, the waste packages received for placement in the mixed and low-level waste side of IDF will have heights that vary from the ILAW package dimensions. In these cases, waste heights will vary from the four layers of ILAW waste described. The total depth, measured from the top of the operations layer to the top of the cover layer over the fourth waste layer, will be 43.4 feet. This is sized for the 7.5-foot tall ILAW package dimension. However, other waste package types can be accommodated. The waste/clean fill depth (43.2 feet) will be uniform over the entire landfill floor, due to the operations layer and the top of the landfill both sloping up 1 percent from north to south. The operations layer will be flat in the east-west direction.

6.2.3 Materials Balance

The IDF was designed to achieve near soil balance. This will minimize excess soil stockpile at the end of the life of the IDF facility and minimize the cost of hauling offsite borrow material for construction. It is important to note that the soil balance was calculated for completing IDF through all its phases and the balance included soil required for construction of the final closure cap. The closure cap design was not part of the critical systems design, completed for this project.

Having a soil balance at the completion of all phases means that at the end of Phase I, a substantial amount (approximately 991,000 cubic yards) of material will be stockpiled onsite. The project design identified potential stockpile sites that were adequate in size for the material to be stockpiled. A portion of the stockpiled material will be used as clean fill during the waste placement in the Phase I cells. However, the stockpile will be replenished during the construction of cells for each subsequent IDF phase.

A description of the resulting soil cut and fill volumes can be found in Appendix C.12.a of this Design Report.

6.2.4 Erosion Control Measures

Permanent erosion control measures (for both wind and water caused erosion) will be provided for areas disturbed by Phase I construction.

Areas that are disturbed by the construction that are outside of the Phase I excavation will be stabilized with a 6-inch-thick layer of topsoil that will be seeded with grass. The south stormwater berm/ditch, the east and west infiltration areas, and the soil stockpiles will also be stabilized with topsoil and grass.

Geotextile and quarry spalls will be placed around each end of the culverts and the stormwater pipe to provide erosion protection.

Stormwater runoff will be conveyed along the south side of the access ramp and the south side of the flat area at the bottom of the access ramp, and will be discharged to the southwest corner of the excavation infiltration area. Road surfacing will reduce the erosion potential on the ramp and flat area. To prevent erosion of the south side slope adjacent to the ramp and flat area, a strip of erosion control matting will be installed on the south side slope, immediately adjacent to the ramp and flat area. Geotextile and quarry spalls will be placed in the southwest corner of the excavation pond in order to minimize the potential of erosion due to the stormwater that will be discharged from the south edge of the flat area to the top of the infiltration area.

Erosion control matting will also be placed on the shine berm to minimize the potential for wind erosion. The erosion control matting will be a plastic matting with an estimated service life at least equal to the 10-year period that the Phase I cells are expected to operate.

To reduce wind erosion, all of the side slopes of the Phase I excavation will be stabilized with a spray-on application of a soil stabilization material. Additional applications of the soil stabilization material may have to be done annually on the areas that remain exposed.

The contractor will also be required to prepare and implement a dust control plan for the construction.

6.3 Lining System Materials

6.3.1 Liner Selection Basis

WAC 173-303-665(2)(a)(i) requires submittal of an engineering report with the permit application under WAC 173-303-806(4) stating the basis for selecting the liner(s). The report must be certified by a licensed professional engineer. The intent of Section 6.3 of the Design Report is to satisfy this requirement of the WAC 173-303, Dangerous Waste Regulations.

Specific requirements to address as the basis for liner selection include:

- The liner must be constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the waste or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation.
- The liner must be placed on a foundation or base that is capable of providing support to the liner and is able to resist pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift.
- The liner must be installed to cover all surrounding earth likely to be in contact with waste or leachate.
- The lining system must include a LCRS immediately above the liner that is designed, constructed, maintained, and operated to collect and remove leachate from the landfill. Design and operating conditions will ensure that the leachate depth over the liner does not exceed one foot. The LCRS shall be:
    - Constructed of materials that are chemically resistant to the waste managed in the landfill and the leachate expected to be generated, and of sufficient strength and thickness to prevent failure under the pressures exerted by overlying wastes, waste cover materials, and any equipment used at the landfill.
    - Designed and operated to function without clogging through the scheduled closure of the landfill.
    - Engineering analyses were presented in Section 5 that address the above requirements for basis of lining selection. Of particular note is Section 5.6 that addresses lining system/leachate compatibility for all components of the lining system. Compatibility of the lining system components with the chemical and radiological constituents of the expected leachate is a critical aspect of the liner selection basis.
    - Based on results of the engineering analyses presented in Section 5, the following liner sections are proposed for the IDF bottom (floor) and side slope lining systems. Section 6.3.2 provides a detailed discussion of the liner materials for the barrier components of the lining system, and Section 6.3.3 provides a detailed discussion of the liner materials for the drainage and protection components of the lining system.

Drawing H-2-830838 (Detail 1) shows the bottom liner section, consisting of the following components, from top to bottom:

- A 3-foot-thick operations layer
- A separation geotextile (polypropylene)
- A 1-foot-thick leachate collection drain gravel layer
- A minimum 12 oz/square yard cushion geotextile (polypropylene)

- A 60-mil textured primary HDPE geomembrane
- An internally-reinforced GCL
- A CDN drainage layer for the LDS
- A 60-mil textured secondary HDPE geomembrane
- A 3-foot-thick low-permeability compacted admix (soil-bentonite) liner

Drawing H-2-830838 (Detail 2) shows the side slope liner section, consisting of the following components, from top to bottom:

- A 3-foot-thick operations layer
- A CDN drainage layer for the LCRS
- A 60-mil textured primary HDPE geomembrane
- A CDN drainage layer for the LDS
- A 60-mil textured secondary HDPE geomembrane
- A 3-ft-thick low-permeability admix liner

6.3.2 Liner Materials – Barrier Components

6.3.2.1 Geomembranes

WAC 173-303-665(2)(h)(i) requires that the IDF lining system have both a primary and secondary geomembrane. The geomembrane for the IDF will serve as leachate barrier and as a flow surface routing leachate to the LCRS sump (for the primary geomembrane) or LDS sump (for the secondary geomembrane).

HDPE has been selected as the geomembrane liner material because it is generally acknowledged to have the highest chemical resistance of commercially-available liner materials, has been widely used at similar facilities, and has a high level of acceptance by regulatory agencies. Details of HDPE geomembrane compatibility with expected leachate is discussed in Section 5.6.

A nominal thickness of 60-mil has been selected for the HDPE geomembrane. A nominal thickness of 60-mil results in a minimal allowable thickness of 54-mil, as indicated in the technical specifications. Thus, 60-mil nominal thickness is the minimum required to achieve the 50-mil minimum thickness specified by Ecology guidance. Textured (roughened) geomembrane will be used to maximize shear strength along adjacent interfaces and to reduce the potential for sliding of the liner system. Analyses of the various stresses that the geomembrane is designed to withstand under construction and operational loads are presented in Section 5.5. Required material properties as a result of these analyses are included in the technical specifications.

Details of required HDPE geomembrane properties are provided in the technical specifications (see Section 02661).

6.3.2.2 GCL

A GCL will only be included in the primary bottom lining system. For the bottom lining system, both the primary and secondary liners will be a composite (geomembrane over admix liner or GCL) system. The addition of a GCL in the primary lining system will provide an extra measure of protection, exceeding the requirements of WAC 173-303-665(2)(h)(i) for a single geomembrane for the primary liner and composite for the secondary only. This will provide an extra measure of protection on the bottom flatter slopes of the IDF, where higher leachate head levels are more likely. A GCL will not be included on the side slope lining system. The 3H:1V side slopes for the IDF will result in little or no leachate head expected on the side slope lining system, thus eliminating the need for a lining system design that exceeds the WAC requirements.

Commercially-available reinforced GCL products consist of bentonite sandwiched between a woven and non-woven geotextile that are then needle-punched together. Other combinations of upper and lower, woven and non-woven geotextiles can also be manufactured and specified.

For the IDF lining system, a needle-punched, reinforced GCL with non-woven geotextiles on both sides was selected. This type GCL product was selected primarily because of the tensile strength requirements required for landfill global stability (Section 5.1.3). The tighter weave non-woven geotextile minimizes the amount of bentonite that migrates to the interface with the geomembrane, thus minimizing the potential to create a slip surface.

Details of required GCL properties are provided in the technical specifications (see Section 02667).

6.3.2.3 Admix Liner

Details of the admix design test program are provided in Sections 4.2.2 and 5.4.1. Placement and testing requirements are described in Section 5.4.2.

The admix liner will have a minimum 3-foot thick compacted soil/bentonite admixture and will be located immediately beneath the secondary HDPE geomembrane, as required by WAC 173-303-665(2)(h)(i)(B). The admix liner typically will consist of base soil mixed with a nominal 12 percent sodium bentonite, by dry weight. Mixing and processing of the base soil/bentonite admixture is required to be performed under carefully controlled conditions, using a pugmill operation.

The base soil for the admix liner will consist of natural soil, derived from the dune sand borrow area to the south of the Phase I cell (as shown on Drawing H-2-830828) or from within Phase I cell excavations. Based on the results of the limited field exploration for near surface base soil samples (discussed in Sections 4.1 and 4.2), base soil from either source will not be excavated below a depth of 5 feet bgs (after stripping) without further evaluation of the material suitability.

Base soils excavated from the dune sand borrow area or site excavation will meet the following requirements:

- The base soil will be free of roots, woody vegetation, frozen material, rubbish, and other deleterious material.
- Rocks greater than 1 inch in dimension will not comprise more than 2 percent by weight of the base soil.
- Base soil will have 20 percent minimum passing a No. 200 U.S. sieve.
- The in-place hydraulic conductivity of the admix liner will be 10-7 centimeters per second or less, consistent with WAC requirements for secondary soil liners. The upper surface of the admix liner will be trimmed to the design grades and tolerances. The surface will be rolled with a smooth steel-drum roller to remove all ridges and irregularities. The result will be a smooth, uniform surface on which to place the overlying geomembrane liner.
- Before production installation of the admix liner, a full-scale test pad of the admix liner will be conducted for both the bottom floor (horizontal) and side slope areas of the IDF. Details of the test pads are provided in the technical specifications (see Section 02666) and the IDF Construction QA Plan. The primary purpose of the test pad(s) will be to verify that the specified soil density, moisture content, and hydraulic conductivity values will be achieved consistently, using proposed compaction equipment and procedures. In-place density will be measured using both the nuclear gauge (ASTM D2922) and rubber balloon (ASTM D2167) or sand cone (ASTM D1556) methods. In-place hydraulic conductivity will be determined from a two-stage borehole permeameter (ASTM D6391). Admix liner hydraulic conductivity will be estimated from thin-wall tube samples (ASTM D1587) obtained from the test fill and tested in the laboratory (ASTM D5084). During construction, field density (e.g., ASTM D2922, D2167, and/or D1556) and moisture content (ASTM D2216) will be measured periodically. Thin-wall tube samples (ASTM D1587) will be taken at regular intervals and will be tested for hydraulic conductivity (ASTM D5084). Additional details of Construction QA testing and acceptance

during admix liner test pad and production installation is provided in the IDF Construction QA Plan.

Details of required admix liner properties and placement requirements are provided in the technical specifications (see Section 02666).

6.3.3 Liner Materials–Drainage and Protection Components

6.3.3.1 Geotextiles

Two types and weights of geotextiles will be used in the IDF project. The separation (Type 1) geotextile has a nominal weight of 6 ounce/square yard and was selected based on the ability of the geotextile to retain the soil and to prevent the soil from entering the LCRS drain gravel. Required AOS and permittivity were determined based on filter, fines retention, and clogging potential criteria. The waste disposed in the IDF is expected to contain a minimal amount of organic material, and consequently, biologic clogging is not expected to be a problem.

The cushion (Type 2) geotextile has a nominal weight of 12 ounce/square yard and was selected based on providing the required cushion protection for geomembrane on the landfill bottom (floor). The drain gravel will have the potential to produce localized stress on the geomembrane liner during gravel placement with construction equipment and under the maximum static pressure from landfill contents at full waste height with final cover. A puncture analysis was performed to select a sufficiently thick geotextile to protect the liner. This analysis included the maximum load from landfill contents and final cover, expected construction vehicle ground pressures, and maximum drain gravel particle size listed in the technical specifications.

Both types of geotextiles are specified as non-woven needle-punched and made from polypropylene material. This material was selected because of its higher chemical resistance to the expected leachate (Golder Associates, 1991a).

Details of required geotextile properties are provided in the technical specifications (see Section 02371).

6.3.3.2 CDN

The CDN is a drainage geocomposite consisting of a HDPE geonet core with a layer of non-woven polypropylene geotextile thermally bonded to each side. The CDN selected for the IDF lining system has two drainage related functions. On the side slopes, it will function as the LCRS. A CDN is selected for the LCRS on the side slope to avoid construction stability problems associated with placement of clean granular material on slopes, thereby minimizing the potential for damaging the underlying liner system. Localized placement of drain gravel is required on side slopes (as shown on Drawing H-2-830848, Section C), to provide adequate backfill and bedding for leachate collection riser piping. On the side slope and bottom lining system, the CDN will function as the LDS.

Analyses were performed to evaluate the geotextile puncture requirements for the LCRS CDN on the side slope and the transmissivity requirements for both the LCRS and LDS CDN. These analyses and discussion are presented in Section 5.7.

The analyses for CDN geotextile puncture resistance determined that the specified geotextile is adequate for resistance to puncture from overlying operations layer, under the maximum static pressure from landfill contents.

The analyses for allowable transmissivity with applied reduction factors for intrusion, creep, and chemical and biological clogging determined that a higher flow, thicker (250 mil minimum) CDN is required, due to the reduction of flow under the high normal loads in the final filling configuration.

Details of required CDN properties are provided in the technical specifications (see Section 02373).

6.3.3.3 Drain Gravel

The LCRS for the bottom liner will be located below the operations layer and will provide a flow path for the leachate flowing into the LCRS sump and sump trough. Between the operations layer and the underlying drain gravel, a geotextile layer will function as a filter separation geotextile (as discussed in Section 6.3.3.1).

The separation geotextile will prevent migration of fine soil and clogging of the drain gravel. The gravel will be a minimum 1-foot thick layer of washed, rounded to subrounded stone, with a hydraulic conductivity of at least 10-2 cm/sec, as required by WAC 173-303-665(2)(h)(iii)(B). In addition, a slotted HDPE leachate collection piping will be placed within the drain gravel to accelerate leachate transport into the LCRS sump during high precipitation events. Slots on the leachate collection piping are sized to be compatible with the drain gravel gradation and particle sizes. Details of the leachate collection piping design are provided in Section 6.4.1.

Based on review of expected subsurface conditions for the IDF, it is not likely that material meeting drain gravel is available on or near the site. Thus, drain gravel will have to be an imported material. The technical specifications require that drain gravel meet the requirements of WSDOT Standard Specification 9-03.12(4) for gradation. The technical specifications also require a performance specification for a hydraulic conductivity greater or equal to 10-1 cm/sec.

As discussed in Section 5.7.3, the minimum estimated hydraulic conductivity for the drain gravel exceeds the required (by WAC regulations) hydraulic conductivity of 10-2 cm/sec by a factor or 100 to 1,000, and the performance specification hydraulic conductivity of 10-1 cm/sec by a factor of 10 to 100. This allows for uncertainty in the empirical formulas used to predict hydraulic conductivity, and the potential for long-term reduction in hydraulic conductivity in the drain gravel, if fines from waste filling and the operations layer migrate into this layer over time.

Details of required drain gravel material properties are provided in the technical specifications (see Section 02315).

6.3.3.4 Operations Layer

The purpose of the operations layer will be to protect the underlying lining system components from damage by equipment and waste canisters during IDF construction and operation. This layer also will protect the admix liner from freeze/thaw damage and desiccation cracking. This is especially the case on the side slopes, expected to be exposed (prior to waste placement) for longer duration than the bottom (floor) of the IDF cell.

The operations layer material typically will consist of onsite granular soil from the IDF Phase I excavation. The excavated material is expected to be a fine-grained sand to silty sand with traces of gravel. The technical specifications require the material to have a maximum particle size limit of two inches or less, and fines will be limited to maximum 25 percent fines (percent passing the U.S. No. 200 sieve). Based on review of expected subsurface conditions for the IDF excavation, the majority of soil excavated from the IDF Phase I excavation is expected to be suitable for use as operations layer without processing. As discussed in Section 4, additional geotechnical exploration within the IDF Phase I limits are recommended prior to construction to verify these findings.

Details of required operations layer material properties are provided in the technical specifications (see Section 02315).

6.4 Leachate Collection System

The leachate collection system for each cell in Phase I will consist of lateral flow media built into the cell's bottom and side slope liner system, a leachate collection pipe in the center of the cell, a sump at the north end of the cell where all leachate drains, pumps and leachate transfer piping to convey leachate out of the cell, and a network of piping and storage tanks for storing the leachate for later transfer to tanker trucks for offsite disposal. Below the bottom liner and under the LCRS sump area will be an LDS sump, pump, and associated piping. All components for Phase I of the leachate collection system are designed and configured for eventual full development of the IDF through Phase IV.

The type and configuration of the leachate collection system described below has been used successfully at other disposal facilities, and a very similar facility was recently (2002) implemented at the INEEL site near Idaho Falls, Idaho. This ICDF will accept waste with radioactive characteristics and is located in a region with dry weather conditions, similar to Hanford.

6.4.1 Leachate Collection Piping

6.4.1.1 Description

Lateral drainage media (drain gravel in the bottom liner section and CDN in the side slope section of each cell) will convey leachate by gravity to the leachate collection piping and to the LCRS sump area. The leachate collection piping system in both cells will have one 12-inch diameter HDPE slotted pipe running the length of the cell centerline from south to north. This main collector pipe will be sloped at 1 percent and will convey leachate from the south edge of the cell to the LCRS sump at the north end, where the bottom liner will intersect the side slope liner. The main collection pipe will change to solid pipe at the bottom of the side slope, continue up the side slope, and terminate at a cleanout, located just south of the crest pad building. Leachate in the sump will be collected through perforated pipes for the LCRS low flow and high flow pumps, which will be 12-inch and 18-inch HDPE slotted pipe, respectively. The riser pipes will protect the pumps and separate them from the surrounding drain gravel, allow removal and re-insertion of the pumps for maintenance, and provide a high inflow-rate screen for leachate to supply the pumps. A small-diameter pipe (housing a transducer to control the on/off levels for the pumps) will run from the LCRS sump up the side slope to the crest pad building.

The slotted portion of the riser pipes will extend from the toe of the side slope to the end of the LCRS sump area. The transducer pipe will also be slotted but for a shorter distance in the LCRS sump, whereupon it will be solid for the remaining distance to the crest pad building. A solid HDPE pipe (of the same diameter as the slotted portion of the pump riser pipes) will extend from the intersection of the side slope and bottom liner to the top of the shine berm where the pipes enter the crest pad building.

Pipe cleanouts will be provided at both ends of the main collection pipe in the center of each cell. The cleanout at the north end of Phase I, near the crest pad building, will be permanently available throughout the life of the IDF to allow access for cleaning and/or video inspection. The cleanout at the south end of the cell will also be available for cleaning and access, but only during the operation of Phase I. It will be removed and the Phase II collection pipe will be butt-fused to the pipe as the Phase II cell is brought online. Ultimately, a permanent cleanout will be installed at the south end of Phase IV, to allow cleaning and inspection of half of the collection pipe, with the other half being accessed by the permanent cleanout located at the crest pad building on the north side of Phase I.

Access to the riser pipes for cleanout or inspection, in the unlikely event this is needed, will be through the access points used for removal and re-insertion of the pumps within the crest pad building.

6.4.1.2 Design Considerations

The material chosen for piping within the Phase I lined area was HDPE, made of resin meeting the requirements of ASTM D3350 for PE 3408 material, with a cell classification of 345434C or higher. Design calculations were based on this material and pipe type, which is routinely used for leachate collection and disposal facilities and other applications. The pipe material is well suited for use in disposal facilities because of its high strength, high resistance to degradation from leachate constituents, and superior characteristics compared to all other readily available pipe materials. HDPE compatibility with leachate and the presence of radioactivity in the waste overlying the pipe were evaluated and discussed previously in Section 5.6.

The diameter of the riser pipes was chosen to provide ample clearance for the pumps to be inserted and removed on a routine basis, and specifically so that the pumps will have sufficient clearance when traveling through the angle points at the intersection of the bottom liner and side slope, and clearance at the radius transition from the side slope to the crest pad building. The pumps (described in Section 6.4.3) are specifically designed for this type of leachate collection system, where the riser pipes allow insertion of pumps down a side slope and into a sump area.

Lateral drainage media in the bottom liner and side slope liner, and the leachate collection piping system were chosen and configured to meet the regulatory requirement of no more than 12 inches of leachate head buildup over the sump area of the bottom liner as a result of a 25-year, 24-hour storm event.

The slots in the slotted pipe were designed to both be compatible with the granular material in the drain gravel and to allow a high rate of flow from the surrounding lateral drainage layers into the pipe. Slots were sized at 0.128 inches wide, with five rows of slots spaced equidistant around the perimeter of the pipe, and eleven slots per foot of pipe.

The thickness of the pipes expressed as the SDR (standard dimension ratio) was chosen to resist the highest estimated load for the IDF in its final configuration, including final cover and equipment loading (internal pressure was not a factor since the pipe will convey flow by gravity, and under the expected flow rates the pipes will only be partially full). A SDR of 17 was chosen for all piping to handle the maximum estimated load. In addition, a blanket of manufactured drain gravel will be placed around and to the sides of all collection piping and compacted to a firm, unyielding condition consistent with the soil modulus values used in the pipe loading calculations.

All piping will be butt-fused for maximum strength, and all fittings, whether available molded from the manufacturer or fabricated, will have the same or higher pressure rating than the pipe. During construction, piping will be butt-fused by certified technicians, using welding equipment approved by the manufacturer. All solid pipe will be pressure tested, even though the collection piping will see little or no internal pressure during gravity conveyance of leachate.

6.4.2 Leachate Transfer Piping

6.4.2.1 Description

At each cell, the leachate transfer piping will begin with the piping from the pumps in the LCRS and LDS sumps to the crest pad buildings. From the crest pad buildings, transfer piping will connect the leachate transfer buildings, storage tanks, and tanker truck load facilit~~y~~ies. The leachate transfer piping between the transfer buildings allows for pumping of leachate from each cell to either tank ~~(see Section 6.4.2.2)~~. All underground transfer piping outside the Phase I liner limits will be double contained, that is the pressure pipe conveying leachate between various facilities will be contained in an outer pipe. The pressure pipe in the center of the double containment piping will be termed carrier pipe, while the outer pipe will be termed containment pipe. In the event of a leak in the carrier pipe, the containment pipe or leak detection pipes draining the containment pipes will convey the leakage to a combined sump facility for detection, sampling, and transfer. Any accumulation of leachate in the combined sump will be pumped through a transfer pipe to the storage tank. Piping within the crest pad building, transfer building, truck load facility, and combined sump, will not be double contained because the buildings or facilities will provide secondary containment and have sumps present to remove any leachate that accumulates as a result of leaking pipes or appurtenances. Leak detection pipes draining containment pipes and the leak detection pipe from the storage tank will be single pipes because they only will convey leakage and will not function as transfer piping (required to have double containment).

The transfer piping system also will include valves, fittings, flow meters, and other appurtenances necessary for operational functions for systems described in Sections 6.4.3, 6.4.4, and 6.4.5.

The leachate transfer pipeline connected through the two leachate transfer buildings 219A1 and 219E1 includes valves located in the transfer buildings is capable of being configured to allow leachate from Cell 1 and from Cell 2 to be transferred to either tank, allow leachate to be transferred between tanks, or for the isolation of a single tank without affecting the removal of leachate from Cells 1 and 2.

The leachate transfer pipeline between the leachate transfer buildings is an underground double walled containment pipe with a 3-in., High Density Polyethylene (HDPE) carrier pipe and a 6-in., HDPE containment pipe. The inter-tank transfer pipeline is designed and constructed to drain to four (4) leachate transfer sumps (LTSs) used for leachate leak detection. The four LTSs are constructed of a 12-in., HDPE riser which is connected to the 6-in., HDPE containment pipe (see H-2-830850 Sheet 2). The design and construction of the inter-tank leachate transfer pipeline are provided in Appendix C9, *Construction Specifications* and Appendix 4A3, *Critical System Design Drawings*. In addition, design calculations are available in CHPRC-03955, *Leachate Loading Calculation* and CHPRC-03956, *Leachate Hydraulic Calculaiton*.

6.4.2.2 Design Considerations

All transfer piping outside of buildings will meet the same requirements as the HDPE pipe chosen for the leachate collection piping (described in Section 6.4.1). Single pipe and containment pipe exposed to earth and traffic loading will be SDR 17, while the carrier pipe, that will not be exposed to earth or traffic loading, will be SDR 21, with a pressure rating of 80 psi and a safety factor of 2 for the highest expected operating pressure in the system (SDR 17 piping has a pressure rating of 100 psi). All piping will be butt-fused except for the transfer piping from the LCRS and LDS sump pumps. This pipe will be HDPE, with quick release fittings to allow removal of the pumps from the sumps. Fittings will be pressure rated and re-useable. As the pumps are withdrawn from the sumps and moved up the riser pipes, each joint in the pipe will be unhinged to allow the pipe to be removed in 8-foot sections.

Piping inside buildings will be PVC, schedule 80, with solvent welded fittings. This pipe and classification is rated for higher pressure than required with a factor of safety of 8. PVC was chosen for application inside buildings because of its relative ease of fabrication with the solvent weld joint system.

Flange connections will be used between pumps and piping; valves and other appurtenances and piping; and joints between PVC and HDPE piping. Appurtenances will include air release valves to allow purging of any air trapped in the piping system, magnetic flow meters for measuring flow to the tanker truck load output and to and from the leachate storage tanks, and valves for flow control and diversion of flow between the various facilities. The flow control scheme and control logic for the transfer piping system are described in Section 6.4.5.

6.4.3 Leachate System Pumps

Three submersible leachate pumps will be required for each cell. For convenience and operational versatility, roller-mounted pumps were selected for all leachate removal facilities. The submersible pumps are standard stainless steel well pumps that have been installed within a screened stainless steel cylinder fitted with rollers. The configuration will allow the pumps to be installed from the crest pad building within riser piping that follows the slope of the landfill until the riser piping bends horizontally to terminate within the cell sump at the toe of slope. This type of pump can be lowered into the leachate sump through the riser pipe and removed as needed, using a winch mounted within the crest pad building. Each pump will have its foot valve removed to prevent freezing or retaining of the leachate in the pump discharge piping. Advantages of this type of pump include easy access for maintenance and inspection, no power equipment required to remove/install, and its small size will lend itself to being inserted within a curved riser pipe and evacuating nearly all of the leachate within the cell sump. Each pump will have the capability to pump either to the storage tank or truck loading station.

6.4.3.1 LCRS Pumps

Two of the three submersible pumps will be installed within the LCRS sump area of each cell above the primary liner. These pumps are required to maintain less than 12 inches of hydraulic head above the primary liner, per regulatory requirements. The pumps will be installed in a 6-inch depression within the LCRS, in order to minimize the area of permanent leachate storage at pump shutoff and allow full pump operation through the 12-inch maximum liner head zone over the primary liner. Only in the localized area of the LCRS sump depression will a maximum leachate head of 18 inches cover the primary liner. The leachate head over the primary liner will be maintained at or below 12 inches in the main sump area and throughout the landfill. One low-flow pump is required for typical pumping of leachate; a high-flow pump is necessary in the event that a large storm (24-hour, 25-year storm event) exceeds the capacity of the low-flow pump.

The selection of the low-flow pump was based on the average leachate flow from the landfill, determined in the leachate production analysis (Section 5.8.1). The analysis indicated that the maximum leachate flow, based on monthly data, is approximately 13 gpm. The hydraulics of the low-flow pump was modeled and a pump was selected, based on the hydraulic characteristics of the piping system and the required flow rate, determined in the leachate system hydraulics analysis (Section 5.9.2.1). An EPG Companies, Inc. (EPG) model WSD 3-3 (or equal) with a 0.5-horsepower motor was selected for the LCRS low-flow pump.

The selection of the high-flow pump was based on the 24-hour, 25-year storm event, determined in the leachate production analysis (Section 5.8.1). The analysis indicated that the high-flow pump capacity necessary to remove the leachate per regulatory guidelines is approximately 160 gpm. The hydraulics of the high-flow pump was modeled and a pump was selected, based on the hydraulic characteristics of the piping system and the required flow rate, determined in the leachate system hydraulics analysis (Section 5.9.2.1). An EPG model WSD 30-3 (or equal) with a 7.5-horsepower motor was selected for the LCRS high-flow pump.

6.4.3.2 LDS Pump

The third submersible pump will be installed within each cell in the LDS sump, under the primary liner and above the secondary liner.

This pump will detect and recover leachate that has leaked through the primary liner by pumping the leachate to the crest pad building. This pump was sized for low leachate generation flows.

The hydraulics of the LDS pump were modeled and a pump was selected that can produce 4 gpm, based on the hydraulic characteristics of the piping system and the required flow rate, identified in the leachate system hydraulics analysis (Section 5.9.2.1). An EPG model 1.5-3 (or equal) with a 0.5-horsepower motor was selected for the LDS pump.

6.4.3.3 Crest Pad Building Sump Pump

The sump pump within the crest pad building will be a submersible floor sump, activated by float switches within the floor sump. The function of the sump pump is to remove leachate that accumulates in the crest pad building as a result of unexpected spills or pipe leaks. The pump discharges water to the leachate storage tank via the crest pad building discharge piping.

The hydraulics of the sump pump was modeled and a pump was specified, based on the hydraulic characteristics of the piping system and the required flow rate identified in the leachate system hydraulics analysis (Section 5.9.2.1).

6.4.3.4 Leachate Transfer Pump

The leachate storage tank will be drained by using the leachate transfer pump, located in the leachate transfer building. The pump was sized to deliver a capacity of 250 gpm to the truck loading station, where it will discharge into a tanker truck. The typical volume allowed in a tanker truck is 7,000 gallons, corresponding to a loading time of approximately 30 minutes.

The hydraulics of the leachate transfer pump was modeled and a pump was selected, based on the hydraulic characteristics of the piping system and the required flow rate, identified in the leachate system hydraulics analysis (Section 5.9.2.1). A standard horizontal centrifugal pump, Paco model 30707 (or equal) with a 3-horsepower motor was selected for the leachate transfer pump.

6.4.3.5 Combined Sump Pump

The combined sump will be a 76-inch-diameter HDPE manhole with a 42 inch diameter HDPE manhole placed inside. The outer manhole will have a height of approximately 8 feet, and the inner manhole height will be approximately 6 feet. The secondary containment portion of all the buried HDPE pipelines, leachate tank, and leachate transfer building floor sump will drain to the annular space (leak detection chamber) between the two manholes. The leak detection chamber will include instrumentation to detect leachate and alarm accordingly. The sumps installed within the truck loading slab typically will collect precipitation that drains off the slab. The precipitation will be conveyed directly to the inner manhole of the combined sump, where the combined sump pump will be located. The combined sump pump then will pump the precipitation to the leachate storage tank.

The combined sump pump was conservatively sized for a capacity of 250 gpm. This large capacity was chosen based on an off-normal event that assumed the tanker truck was overtopped during leachate transfer activities, resulting in 250 gpm flowing into the inner sump. Another off-normal event considered was the remote possibility that the leachate tank primary liner failed catastrophically. This flow of leachate could eventually inundate the leak detection chamber and overflow into the inner manhole.

The hydraulics of the combined sump pump was modeled and a pump was selected based on the hydraulic characteristics of the piping system and the required flow rate, identified in the leachate system hydraulics analysis (Section 5.9.2.1). A Hydromatic model SB3S (or equal) with a 3-horsepower motor was selected for the combined sump pump.

6.4.4 Leachate Temporary Storage Tank

6.4.4.1 Tank Volume

A leachate temporary storage tank is required for each cell. The working capacity of each tank is 375,000 gallons that include a 1.5 safety factor. This volume is based on the results of the leachate production analysis (Section 5.8.1) and the leachate collection storage analyses (Section 5.9.2.4). The storage tank capacity is dependent on the net volume of leachate accumulation in the tank from flow into and out of the tank. The flow out of the tank via the leachate transfer pump is based on several assumptions, described in Section 5.9.2.4. Actual leachate transfer operations will affect the tank volume safety factor.

6.4.4.2 Tank Design

A bolted, corrugated steel tank, approximately 100 feet in diameter with a side wall height of 8 feet 2 inches, was selected for use as the leachate temporary storage tank. The tank will include a dual containment liner system that will act as the floor of the tank and will be bolted to the top of the tank side wall. The tank will be ~~open-topped~~covered with a ~~floating geomembrane~~ cover to keep precipitation, debris, and wildlife from contacting the leachate.

The tank side wall will be bolted to a 1.5-foot thick, 4-foot-deep concrete ringwall to resist hydrostatic pressure of the leachate water. In addition, the top edge of the tank ringwall will include angle bracing, bolted around the tank perimeter to provide rigidity in the side wall to resist wind loads on the exterior of the tank. The maximum operating level of the tank is approximately 6 feet 2 inches; however, the tank is designed for a maximum water level of 8 feet 2 inches.

The inlet piping for the tank will be through the side wall of the tank. The inlets will all be located near the top of the tank, above the maximum leachate water operating level. This is to ensure that a siphon cannot develop in the inlet piping. Check valves will be installed throughout the system; however, if piping between the check valve and the tank leaked into the secondary containment system, there would not be an easy method of stopping the flow if the pipe was below the water surface of the tank.

The outlet pipe for the tank will be through the side wall, near the bottom of the tank. This method was chosen to provide a flooded suction for the leachate transfer pump that will provide added protection against pump damage.

6.4.4.3 Tank Liners

The tank liners will be constructed with an XR-5 geomembrane. XR-5 is a proprietary geomembrane manufactured by Seaman Corporation. XR-5 is the preferred liner of several tank manufacturers due to its higher strength properties and lower thermal expansion coefficient, as compared to HDPE geomembrane. As such, it is more readily constructible in the tank configuration, and it does not expand and contract as much as HDPE, so it's operating performance over the temperature range at Hanford should be improved. For the exposed condition at the IDF tanks, this is an important consideration. HDPE was considered for use as the tank liner system, but its high coefficient of expansion will not lend itself to the temperature extremes that the liner system will be subjected to and also it is not reinforced like the XR-5. The expansion and contraction of an HDPE liner exposed to the environment could put undue strain at the inlet and outlet connections as well as at the leak detection connection that could result in liner leakage.

Chemical compatibility of leachate with the liner system is also a consideration for liner material selection for the leachate storage tanks. As discussed in Section 5.6.3.1, compatibility testing on HDPE geomembrane was performed with synthetic leachate for the W-025 landfill with no evidence of geomembrane deterioration. With regard to leachate compatibility, XR-5 is comparable to HDPE in terms of compatibility with typical leachate constituents. The geomembrane manufacturer requires immersion testing for conclusive compatibility determination. Testing of this type has not been performed, but the manufacturer is confident that immersion testing results will be acceptable since XR-5 is generally comparable to HDPE.

To address the issue of chemical and radiation resistance for XR-5 with anticipated leachate constituents, an immersion test program is included in the technical specifications for the tank liner. Details are provided in Section 13205 of the technical specifications. This immersion testing program requires the construction general contractor to submit tank liner sample coupons to the design engineer for immersion testing, as part of the construction submittal process and certification of the tank liner.

In addition, it should be noted that leachate compatibility is not as critical an issue for the tank system as compared to the landfill liner system. The leachate tank liner system will be subject to continuous monitoring through the tanks' LDS, as is the landfill liner system. The difference is that the tank liners will be subject to routine maintenance and inspection that will be developed around liner warranty, performance observation, and manufacturer's requirements. Operation and maintenance procedures for the tank will be established that require that the tanks be drained, sediment removed, and the liner inspected for holes and seam integrity. Since liner performance guarantees are required in the technical specifications for the tank manufacturer for three years following installation, it is likely that the inspection program would be initially set up around this time frame and gradually be increased over the life cycle of the tank. Replacement of the leachate tank liner system is anticipated periodically throughout the life cycle of the landfill.

The tank lining system is a double-lined system. The primary and secondary tank liners will include a LDS beneath the primary tank liner. The LDS consists of a HDPE drainage net with a geotextile material, laminated to the drainage net that cushions the XR-5 liner. A geotextile material will also be used between the secondary liner and the inside face of the tank shell to create a cushion for the XR-5 against the tank shell and tank shell bolt heads. The bolt heads are also recessed for further liner protection.

6.4.4.4 Tank Leak Containment System

The HDPE drainage net between the primary and secondary liner will allow leachate that leaks through the primary liner to drain to the center of the tank. At the center of the tank under the secondary liner will be a depression in the underlying granular backfill that will form a shallow sump. The leak detection pipe will connect to the secondary liner at this sump location and convey leaking leachate to the leak detection chamber of the combined sump.

The tank inlet and outlet penetrations will be areas susceptible to leaks as a result of penetrations through the primary liner. Additional robust methods for sealing these locations were added over and above the typical manufacturer recommendations in an effort to make sure that these will not be points of leakage.

6.4.4.5 Fabricated Dome Cover

The Leachate Tanks were initially constructed as open-topped with floating geomembrane covers (as described in the Construction Specification, Appendix C9, Section 13205 – Lined Bolted Steel Liquid Storage Tanks Sched. B). The floating cover design was problematic as water (precipitation) and windblown sediment accumulates on top of the floating geomembrane cover, resulting in increased maintenance. To reduce the required maintenenace and to extend the life of the tank covers, the floating tank covers are replaced with engineered/pre-fabricated aluminum dome covers.

The storage tanks are not designed to support a dome cover (see Section 5.12.2.4), therefore the tank dome cover is supported by separate steel structures and concrete foundations located around the outside of the tank. The design and construction of the fabricated dome cover and structural supports are included in Appendix C9, Construction Specifications, and Appendix 4A3, Critical System Design Drawings. In addition, the structural calculations for the tanks supports and foundations is in CHPRC-04065, *Tank Cover Support and Foundation Calculaitons.*

The placement of the dome cover does not interfere with the tank level instrumentation located in the two stilling wells inside each tank. Access to the stilling wells and instrument interfaces is accessible through an access hatch in the dome as required in Appendix C9, Section 13 34 23.19, Fabricated Dome Structures, Part 2.2.F.8.

6.4.5 Pump Controls and System Instrumentation

The process and instrumentation diagrams for Cell 1 and Cell 2 are shown on Drawing H-2-830854, sheets 1 through 4. Detailed information regarding the instrumentation and control system, equipment listing, instrument listing, and loop descriptions can be found in the technical specifications, Section 13401 (Process Instrumentation and Control System).

6.4.5.1 Crest Pad Building

The leachate pumps within the landfill will be automatically controlled, based on leachate level set points within the cell sump. The level transducer that controls the LCRS pumps will be inserted into the sump via a slope riser pipe. The level transducer that controls the LDS pump is integral to the LDS pump. Leachate pumped by the leachate pumps will be monitored by a flow-indicating totalizer within the crest pad building. Controls will be in place to stop automatically the leachate pumps operation if alarm conditions are present for the leachate storage tank high-high level, leak alarm in the crest pad building sump, or a leak alarm in the combined sump.

The crest pad building sump pump will be automatically controlled by float switches within the building floor sump. In addition, a leak detection switch will be installed in the floor sump that will be capable of detecting small quantities of water in the sump before the float switches. This feature will add an extra level of conservatism to make sure unexpected spills are identified and controlled immediately.

Controls will be in place to stop automatically the crest pad building sump pump operation if alarm conditions are present for the leachate storage tank high-high level or for a leak alarm in the combined sump.

6.4.5.2 Leachate Transfer Building

The leachate transfer pump will be manually controlled except for automatic shut-off during specific alarm events. Controls will be in place to stop automatically the transfer pump operation if alarm conditions are present for the leachate storage tank low-low level or for leak alarm in the combined sump. Additional instrumentation (associated with the leachate transfer pump) will include a flow meter (measuring rate and total volume) and transmitter on the discharge of the leachate transfer pump. In addition, a local totalizer will be in the leachate transfer building to know exactly how much water is being transferred to the tanker truck. This totalizer will include a reset function to allow the total to be reset to zero, prior to every truck loading event.

6.4.5.3 Leachate Storage Tank

Instrumentation within the leachate storage tank will be contained within two vertical stilling wells~~ that will penetrate through openings in the floating cover~~. The stilling wells will be small diameter pipe with perforations near the bottom that will allow the leachate within the stilling well to rise and fall with the level of the leachate in the tank. Analog instrumentation within one stilling well will provide a signal to the control system for alarm interlocks and constant monitoring of tank level. The second stilling well will contain discrete instrumentation for high-high and low-low alarm set point trips. The discrete instrumentation will provide conservatism in the off chance that the analog signal malfunctions, allowing the leachate level to reach extreme high or low levels.

The placement of the dome cover does not interfere with the tank level instrumentation located in the two stilling wells inside each tank. Access to the stilling wells and instrument interfaces is accessible through an access hatch in the dome as required in Appendix C9, Section 13 34 23.19, Fabricated Dome Structures, Part 2.2.F.8.

6.4.5.4 Combined Sump

The combined sump pump will be automatically controlled by float switches within the inner manhole of the combined sump. Controls will also be in place to stop automatically the combined sump pump operation if alarm conditions are present for the leachate storage tank high-high level. A leak detection switch also will be installed within the leak detection chamber that will be capable of detecting a small quantity of water. The leak detection switch will provide a signal to the control system that automatically will shut down all the cell pumps except the combined sump pump. The pumps will be shut down because any one of the pipelines associated with the pumps could be leaking into the leak detection chamber. Operations will then need to determine which secondary containment pipeline supplied the water that drained into the leak detection chamber.

6.4.6 Process Instrument Control System (PICS)

6.4.6.1 Introduction

This section provides a summary of the PICS design and construction elements of the project, providing introduction and reference to the project layout and key design components for the following IDF facilities:

- IDF leachate collection and handling crest pad facilities (two each)
- IDF leachate storage tank and leachate transfer facilities (two each)
- IDF truck loading facilities (two each)

The PICS design identifies, specifies and integrates PICS components to automatically monitor and control IDF process control equipment and facilities including:

- LCRS
- LDS
- Crest pad and leachate transfer building environmental controls
- Leachate storage tank system
- Leachate transfer and truck loading system
- Combined sump system
- Secondary containment LDS

6.4.6.2 Key Design Components (Elements)

PICS design and construction elements of the project incorporate the following key PICS design components for each IDF facility:

- Instrumentation for continuous analog process monitoring

- Instrumentation for discrete process monitoring
- Instruments and programmed safety interlocks and alarming
- Programmable logic controller (PLC) system
- Operator Interface Unit (OIU)
- Communication Local Area Network (LAN)
- PICS application software
- Main and local control panels
- Uninterruptible power supply

6.4.6.3 Open Items

The IDF Phase I Critical Systems design documents do not identify the following items:

- Identification of communication LAN from IDF control panels to central supervisory control and data acquisition (SCADA)
- Extension of communication LAN from IDF control panels to central SCADA

These items are scheduled to be addressed during the IDF Phase I Non-Critical design of the project. As such, the following assumptions were made in order to complete IDF Phase I Critical Systems design:

- Assume 10/100 megabits per second (MBPS) Ethernet communication LAN from IDF control panels to central SCADA
- Assume fiber-optic multi-mode extension of communication LAN from IDF control panels to central SCADA

6.4.6.4 PICS Architectures

The PICS design identifies various architectures, designed to enable operators to locally and remotely interface and change program settings by the use of an Ethernet LAN. This document does not identify components and architectures to be provided and configured under the IDF Phase I Non-Critical design in order for personnel remote monitor and control processes over the LAN.

6.4.6.5 PICS Instrumentation Architecture

The PICS design identifies instrumentation architecture that consists of single variable level (submersible pressure), flow, and temperature elements and transmitters that provide continuous process data to PICS PLC and OIU architectures. Process signals from each instrument are monitored for the purpose of controlling, displaying, recording, and alarming all process data. PICS instrumentation will be wired directly into PLC input modules (i.e., Allen-Bradley 1746 I/O modules).

6.4.6.6 Instrumentation

The PICS design identifies all set-point adjustments as being programmed into the PLC via the OIU architecture. Field instruments incorporate the following signal types:

- Analog signals, current type: 4-20 mA dc signals conforming to ISA S50.1.1
- Transmitters type: 2-wire and 4-wire
- Transmitter load resistance capacity: Class L
- Fully isolated transmitters and receivers
- Discrete signals, voltage type: 24 VDC

6.4.6.7 Analog Instrumentation

The PICS design identifies flow analog instrumentation, consisting of electromagnetic flow elements and integral transmitters that will enable operators to monitor pump discharge flow for the following processes:

- Landfill LCRS pump discharge flow
- Landfill LDS pump discharge flow
- Leachate transfer truck loading station discharge flow

The PICS design identifies level analog instrumentation, consisting of submersible pressure transmitters that will enable operators to monitor liquid levels for the following:

- Landfill LCRS
- Landfill LDS
- Leachate storage tank system

The PICS design identifies temperature analog instrumentation, consisting of an element and transmitter that will enable operators to monitor temperature levels inside the following:

- Crest pad buildings
- Leachate transfer buildings

6.4.6.8 Discrete Instrumentation

The PICS design identifies level instrumentation, consisting of radio frequency (RF) admittance probes and transmitters that will enable operators to monitor discrete liquid levels inside the leachate storage tank system. The PICS design identifies level discrete instrumentation, consisting of magnetic float switches that will enable operators to monitor discrete liquid levels inside the following:

- Crest pad building sump
- Combine sump
- Combine sump interstitial

The PICS design identifies operator instrumentation, consisting of switches, indicating lights, and control relays that will enable operators to monitor the following discrete status:

- Crest pad building and control power status
- Landfill LCRS pumps ON/OFF, AUTO and FAIL status
- Landfill LDS pumps (on/off, auto, and fail) status
- Combined process sump pump (on/off, auto, and fail) status
- Leachate transfer pump (on/off, auto, and fail) status

6.4.6.9 PICS Programmable Logic Controller (PLC) Architecture

The PICS design identifies PLC architecture designed around Allen Bradley Ethernet small logic control technologies. PLC architecture consists of the following:

- PLC processor.
- PLC input/output (I/O) modules.
- PLC ancillary power supplies, chassis and cabling.
- PLC application and development software and hardware.
- The PLC processor is the microprocessor-based device that uses programmable ladder logic for implementing process monitoring and control, emulating the functions of conventional panel-mounted equipment such as relays, timers, counters, current switches, calculation modules, Proportional, Integral and Derivative controllers, stepping switches, and drum programmers.
- PLC(s) are programmed to interface with instrumentation and process motor control equipment. PICS PLC(s) are programmed to automatically operate (start/stop) all process control equipment as well as process flow totals, equipment runtime, operation alarms, equipment, and building status.

- Instrument architecture (analog and discrete control devices) interface with PLC via PLC I/O modules, installed in a common chassis with the PLC power supply.
- The type of I/O modules utilized include analog (4-20 mA) input, 24VDC discrete input, and 120VAC/ 24VDC discrete output.
- The PICS design identifies PLC application software that provides functions unique to the project and not provided by PLC system software alone, such as programmable controller ladder logic, math operations on input process variables (scaling, alarming, totalizing, comparisons).
- The PICS design identifies PLC standard system software packages that enable personnel to communicate and program PLC processor and configure I/O modules. PLC development and application software reside on the programming laptop from which the application is downloaded into the PLC processor.

The PICS design identifies communication protocols establishing data exchange between PLC, programming laptop, OIU architecture, and future remote SCADA as follows:

- Allen Bradley RS-232, RS-4585, and DF1
- Ethernet

6.4.6.10 PICS Operator Interface (OIU) Architecture

The PICS design identifies OIU architecture that allows operators to visually monitor process system data and interface with the facility's programmable logic controllers. OIU enables operators to view alarms and change process set points.

PICS OIU architecture is designed around Allen Bradley PanelView, communicating with PLC architecture over a communication local area network. OIU architecture includes:

- OIU assembly.
- Local area network copper cabling.
- OIU application and standard system software.
- The PICS design identifies OIU application software that provides functions unique to the project and not provided by system software alone. These include, but are not limited to, programmable controller ladder logic, databases, reports, control strategies, graphical display screens, and operation scripts.
- The PICS design identifies OIU standard system software packages that enable personnel to communicate and program OIU. OIU application and standard system software reside on the programming laptop from which the application is downloaded into the OIU processor.

6.4.6.11 PICS Communication LAN Architecture

The PICS design identifies communication between PLC processors, OIU, programming laptop, and future IDF SCADA over a local area network consisting of a local 10/100 MBPS Ethernet switch, local PLC, OIU LAN drivers, and a cable system. The PLC processor and OIU are addressable over the LAN, allowing each device to share data and control points between each other and future devices.

6.4.6.12 Back Up Power

The PICS design identifies UPS mounted inside each main control panel. UPS(s) was sized to enable PLC and OIU networks to maintain monitoring of process control systems during a power failure as well as provide for an orderly shutdown. UPS does NOT power process control equipment such as solenoids, instruments, motorized valves, pumps, and motors.

6.4.6.13 Control Panels

The PICS design identifies the main control panel, mounted inside each crest pad building housing PLC processor and associated I/O modules, ancillary power supplies, termination devices, UPS, and control circuit protection devices. OIU and process flow and level indicators are mounted on front doors of control panels.

The PICS design identifies local control panels, integrating discrete level instrumentation, control relays, intrinsic safety relays, and providing interlock signals between PLC architecture and MCC pump controls.

6.5 Stormwater Management

The proposed stormwater system to be constructed just south of the south end of the Phase I excavation will intercept stormwater runoff from the area to the south for the 24-hour, 25-year storm event so that it will not flow into the Phase I excavation and will discharge the intercepted stormwater into the ground via infiltration. This system will consist of the south stormwater berm/ditch, two culverts, and the east and west infiltration areas. The berm will be two feet high above the existing ground surface. The minimum combined depth of the berm and ditch will be two feet. The ditch will be V-shaped with 3:1 side slopes. The culverts will be 18-inch-diameter, corrugated polyethylene pipe with smooth interior. Geotextile and quarry spalls will be placed around each end of the culverts to provide erosion protection. The east and west infiltration areas will have bottom lengths of 220 and 225 feet, respectively. Each of the infiltration areas will have a bottom elevation of 719 feet and a bottom width of 15 feet. In order to allow access for future maintenance into each of these infiltration areas, their north and south ends will be sloped at 15 percent and surfaced with quarry spalls placed on a geotextile.

The proposed stormwater system to be constructed at the south toe of slope within the Phase I excavation will intercept stormwater runoff from the unlined portions of the excavation for the 24-hour, 25-year storm event so that it will not flow into the active cells and will discharge the intercepted stormwater into the ground via infiltration. This system will consist of the excavation stormwater berm/ditch, a stormwater pipe, one catch basin, and the excavation infiltration area. There also will be a flow path along the south side of the access ramp that will continue along the south side of the flat area at the base of the access ramp and into the southwest corner of the excavation infiltration area. The south stormwater berm/ditch will slope to drain to the east. The combined depth of the berm and ditch will be two feet. The stormwater berm will be 2 feet high at its west end, and the corresponding depth of the ditch will be zero. The berm will gradually reduce in height as the depth of the ditch increases. The berm will end when the ditch depth reaches 2 feet. The ditch will be V-shaped with 3:1 side slope on the south and 2:1 side slope on the north. The stormwater pipe will be 18-inch-diameter corrugated polyethylene pipe with smooth interior. Geotextile and quarry spalls will be placed around each exposed end of the stormwater pipe to provide erosion protection. The catch basin will be used to lower the elevation of the stormwater pipe so that there will be adequate cover over the pipe for protection against wheel loads. The infiltration area will have a bottom elevation of 678 feet, a bottom width of 15 feet, and a bottom length of 50 feet. In order to allow access for future maintenance into this infiltration area, the west end will be sloped at 15 percent and surfaced with quarry spalls placed on a geotextile.

If the water builds up in the east or west infiltration area, it will eventually flow out of the north end of the infiltration area. The water would flow overland, north along the toe of the fill for the berm access road, and continue generally northward.

If the water builds up in the excavation infiltration area so that it extends into the ditch, then the operator will have to bring in a portable pump and pump the water into the east infiltration area.

Maintenance for each of the infiltration areas, the ditches, and the ends of each of the culverts and stormwater pipes will be primarily to remove accumulated sediment and debris.

6.6 Building Systems

6.6.1 Crest Pad Buildings

The crest pad building is designed as a pre-engineered, rigid frame metal building on a slab-on grade foundation. The building slab is separated into two portions. The lower portion of the slab is where the piping associated with the leachate pipe will be contained, and the higher slab is where the electrical and control equipment will be located. The slab where the leachate piping will be located is lowered to create a containment area for the leachate. Construction joints within this area have waterstops to ensure that leachate cannot egress through the construction joints. Additionally, a sump has been placed to drain the containment area, if required. The entire floor and sump area also is to be coated to provide even greater resistance to the leachate.

6.6.2 Leachate Transfer Buildings

The leachate transfer building is designed as a pre-engineered, self-framing metal building on a slab-on-grade foundation. The metal building is supported on an 8-inch curb that travels continuously around the exterior of the building. The curb is continuous, even through the door threshold, to provide a containment area for the leachate in case of spillage. In order to maintain conformance with building code requirements, a landing is used to eliminate the curb tripping hazard at the door threshold. Construction joints within this area have waterstops to ensure that leachate cannot egress through the construction joints. Additionally, a sump has been placed to drain the containment area, if required. The entire floor and sump area also is to be coated to provide even greater resistance to the leachate.

6.6.3 Truck Loading Station

The truck loading station is designed to receive trucks to load with leachate. The station is essentially a slab-on-grade. The station is designed to contain minor spillage of leachate by sloping the floor slab towards the center and using rounded curbs at the slab entrance and exits. Two sumps will be placed in the center of the station to drain the station as required. The entire floor and sump area also is to be coated to provide even greater resistance to the leachate.

6.7 Electrical Service and Lighting

6.7.1 Introduction

This section provides a summary of the electrical design and construction elements of the project, providing introduction and reference to the project layout and key design components for the following IDF facilities:

- IDF leachate collection and handling crest pad facilities (two each)
- IDF leachate storage tank and leachate transfer facilities (two each)
- IDF truck loading facilities (two each)

The electrical design identifies, specifies, and integrates power distribution systems that incorporate transformers, breaker panels, motor control, safety switches, conductors, and lighting for the safe, reliable, and maintainable operation of IDF process and facility equipment including:

- Process equipment (leachate collection and removal pump motors, leak detection pump motors, transfer pump motors, and instrumentation)
- Building facility equipment (lighting, power outlets, heating units, cooling fans, and building sump pumps)
- Personnel and equipment safety systems (standby egress lighting, process alarm lighting, surge protection, and process piping heat trace)
- Electrical design and installation shall be in accordance with NFPA 70 (NEC, 2002)

6.7.2 Key Design Components (Elements)

Key electrical design components (elements) for each IDF facility include:

- Electrical secondary service and monitoring
- Electrical secondary service and feeder protective device coordination
- Electrical secondary service ground electrode system
- Electrical service, equipment, and associated metal structures grounding
- Electrical low voltage motor control

- Facility maintenance outlets (standard, ground fault circuit interrupter [GFCI], weatherproof)
- Facility interior, exterior, and egress safety lighting
- Facility environmental control (heating and cooling)
- Facility hazardous classification
- Process equipment heat trace, ambient monitoring, and power indication
- Facility electrical system surge and phase protection
- Materials and methods of electrical construction (i.e., conduit, wire, control and safety device, and enclosure selection)

6.7.3 Open Items

IDF Phase I Critical System design documents do not identify the following primary and secondary electrical service items:

- Exact location of primary 13.8 kV, 3-phase tie-in
- Exact value of available primary short circuit current at primary tie-in location
- Exact length of primary extension
- Exact location, size, and impedance of utility step-down 13.8 kV – 480/277V, 3-phase, 4-wire pad mounted transformer(s)

6.7.4 Assumptions to Open Items

These items are scheduled to be addressed during the IDF Phase I Non-Critical design. As such, the following assumptions were made in order to complete the Phase I design:

- Assume electrical service gear inside each Cell 1 and Cell 2 crest pad building are powered by separate pad mounted utility transformers.
- Assume pad mounted utility transformers are rated 75 kVA and are installed within 100 feet of respective Cell 1 and Cell 2 crest pad buildings.
- Assume each pad mounted utility transformer is radial fed from a common 13.8 kV primary feeder.
- Assume each Cell 1 and Cell 2 leachate transfer building is powered from electrical service gear, located inside respective crest pad buildings.
- Assume utility short-circuit contribution to be 100 MVA at 13.8 kV, three-phase.

6.7.5 Crest Pad Building Electrical Secondary Service and Metering

Electrical design identified 480 volt, 3-phase, 4-wire secondary service cables eventually powering a service-rated MCC mounted inside each crest pad building.

Type	Designation	Configuration
Cell 1 Service rated MCC	219A-LH-MCC-001	480V, 3-ϕ, 3-wire, 4-wire
Cell 2 Service rated MCC	219E-LH-MCC-001	480V, 3-ϕ, 3-wire, 4-wire

The service-rated MCC will operate as a main service gear, power distribution center, and motor control assembly. A MCC distributes 480 volt, 3-phase power to the following 3-phase equipment:

- LCRS three-phase pump motors
- LDS three-phase pump motor
- Combine sump three-phase pump motor
- Crest pad building and leachate transfer building unit heaters
- Crest pad and leachate transfer lighting panel transformers

Secondary 3-phase power is monitored by phase loss and phase reversal protection relays mounted inside MCC(s). In the event of a phase loss or phase reversal condition, the protection relay will shunt the MCC main service breaker. With main service breaker shunted (open), a UPS mounted inside each PICS main control panel will continue the operation of voltage sensitive PICS equipment (i.e., PLC, OIU, local area network communication), allowing for future remote alarming (future SCADA) and the safe shutdown of sensitive equipment.

Incoming power is also monitored through the use of analog-style voltage and current meters. Operators will be able to observe operating status of incoming power by manually selecting analog-style voltage and current meters to Phase A, Phase B, and Phase C.

MCC associated gear (frame, bussing, and feeder protective devices) were sized to adequately and safely handle the calculated design and demand operating loads, and to safely withstand calculated short circuit interrupting currents.

6.7.6 Utilization Voltages

The electrical design identified utilization voltages for the following equipment and systems:

Equipment or System	Voltage, Phase
Lighting	120 V, 1-ϕ
Heat trace	120 V, 1-ϕ
Convenience outlets	120 V, 1-ϕ
Instrumentation control circuits	24 V DC
Motor control	120 V, 1-ϕ
Air conditioner	208 V, 1-ϕ
Motors, less than 1/3 hp	120 V, 1-ϕ
Motors, 1/3 hp and larger	480 V, 3-ϕ
Unit heaters	480 V, 3-ϕ
Instrument power	120V, 1-ϕ

6.7.7 Leachate Transfer Building Electrical Service

The electrical design identified three phase motor loads inside leachate transfer buildings as being powered from MCC, located inside each crest pad building. Power will be routed from MCC to service-rated disconnect, wire-way, enclosed breaker, and mini-power center (panel/transformer assembly), located inside each leachate transfer building.

Type	Designation	Configuration
Cell 1 service-rated disconnect	219A1-LH-SW-002	480V, 3-ϕ, 3-wire, 4-wire
Cell 2 service-rated disconnect	219E1-LH-SW-002	480V, 3-ϕ, 3-wire, 4-wire

6.7.8 Crest Pad and Leachate Transfer Building Lighting Panelboards

The electrical design identified lighting panel boards installed in each IDF facility to provide 120/208V 3-ϕ, 4-wire power to non-three-phase motor loads. Lighting panelboards will be fed from 480V-120/208V 3-ϕ, 4-wire step-down transformers. Lighting panelboards inside crest pad buildings will be mounted along with step-down transformers inside MCC. Lighting panelboards (mini-power centers, along with integral step-down transformers) inside leachate transfer buildings will be wall mounted.

Type	Designation	Configuration

Cell 1 crest pad building lighting panel	219A- LH-LP-001	120/208V, 3-ϕ, 4-wire
Cell 1 crest pad building lighting panel	219E- LH-LP-001	120/208V, 3-ϕ, 4-wire
Cell 1 leachate transfer building lighting panel	219A1- LH-LP-002	120/208V, 3-ϕ, 4-wire
Cell 2 leachate transfer building lighting panel	219E1- LH-LP-002	120/208V, 3-ϕ, 4-wire

Lighting distribution panelboards will provide 120 volt power to all single-phase equipment including:

- Building lighting.
- Emergency lighting
- Receptacles.
- Main control panel.
- Instrumentation will be powered from surge-protected circuit breakers inside each crest pad building main control panel.
- Lighting distribution panelboards will provide 120/208 volt, single and three-phase power to equipment including the building air conditioner, and heat tracing for process piping.

6.7.9 Feeder and Branch Circuits

The electrical design identified feeder and branch circuit breakers and conductor's size, based upon connected and operating loads. Style of feeder and branch circuit breakers will be thermal-magnetic.

6.7.10 Raceways

480V power circuits–Standard rigid galvanized steel (RGS) in exposed locations, PVC conduit systems will be buried, RGS will be coated when conduits transition from below grade to above grade areas

120V power circuits–Standard RGS in exposed locations, PVC conduit systems buried, RGS coated when conduits transition from below grade to above grade areas.

6.7.11 Raceway Sizing, Selection, and Installation Guidelines

The electrical design identified conduit wire fill and size, based upon THW (thermoplastic, vinyl insulated building wire; flame retardant, moisture and heat resistant, 75°C, dry and wet locations) insulated conductors for wiring 600 volts and below. Minimum raceway sizes will be as follows in the designated locations:

Minimum Raceway Size:	Location:
3/4-inch	Exposed on walls and ceiling
3/4-inch	Concealed in frame construction and finished ceilings
1-inch	Underground for circuits below 600 volts, including instrumentation
3-inch	Fiber optic

The electrical design identified underground raceways assemblies as concrete duct bank constructed.

6.7.12 Wire and Cable

The electrical design identified stranded copper conductors that will be used for all wiring, except for lighting and receptacle circuits where solid copper will be used.

Minimum conductor size of No. 12 will be used for power and lighting branch circuits. Conductors installed in all branch circuits rated 100 amps or less was sized based upon NEC table for 60°C TW conductors.

- No. 12 AWG copper for lighting and receptacle branch circuits
- No. 10 AWG, minimum, wiring for all outdoor power circuits

- No. 14 AWG, minimum, for all instrumentation 24VDC discrete control and instrument power
- No. 16 AWG, minimum, shielded for all instrumentation 24VDC analog control

6.7.13 Convenience Receptacles

The electrical design identified weatherproof 20 amp duplex receptacles for indoor service, weatherproof GFCI 20 amp duplex receptacles for outdoor service.

6.7.14 Motor Control

The electrical design identified full voltage non-reversing (FVNR) combination motor starter assemblies, to be mounted inside MCC for each constant speed motor. FVNR combination motor starter assemblies will consist of thermal-magnetic, trip-molded case circuit breakers; full voltage combination starters; control power transformers; indicating lights; and control switches. All combination motor starters will be operated in AUTO mode by PICS.

6.7.15 Overload Protection

The electrical design identified each motor as being provided with thermal overload protection in all ungrounded phases. Each controller will be provided with overload heaters and controller-mounted relays with external manual reset.

6.7.16 Grounding

The electrical design identified the grounding electrode system for each IDF facility, integrating ground ring rods, and connection to building rebar. The electrical design identified electrical service neutral, and the neutrals of derived sources, electrical equipment, and PICS control panels that will be bonded to grounding electrode systems.

6.7.17 Equipment Grounding

The electrical design identified noncurrent-carrying parts of all electrical equipment, devices, panelboards, and metallic raceways that will be bonded to grounding system.

The electrical design identified noncurrent-carrying parts of all mechanical equipment, to which electrical components will be attached and may potentially become energized, that also will be bonded to the grounding system, including building metal structures and leachate storage tank.

All conduits that will be provided have an equipment grounding conductor.

6.7.18 Lighting

The electrical design identified lighting fixtures that will be installed at each IDF facility to maintain an average 25-foot candle inside each building, and 5-foot candles at entrance doorways.

Note: Interior lighting levels are based upon *IES Lighting Handbook Indoor Industrial Areas Recommended Illuminance Levels* for interior activities inside work spaces where visual tasks of medium to large contrast are to be performed on occasional basis.

Note: Exterior entrance lighting levels are based upon *IES Lighting Handbook Outdoor Site/Area Recommended Illuminance Levels* for building exterior entrances frequently visited locations.

6.7.19 Emergency Lighting System

The electrical design identified emergency illumination (battery-pack wall-mounted units or luminaries powered by integral battery-powered ballasts) that will be provided in all IDF facilities.

6.7.20 Circuiting and Switching

The electrical design identified interior process area lighting, switched to provide adequate lighting. Exterior building lighting will be controlled by photocells.

6.7.21 Heat Trace

The electrical design identified electrical heat trace for above grade process piping freeze protection. Heat trace cable will be the self-limiting type with the overall system controlled by an ambient control thermostat. Heat trace design incorporates circuit power indication.

6.7.22 Hazardous Classification

The electrical design identified the interior of the combined sump as Class 1, Division 2 group, C hazardous. The electrical design for the combined sump will incorporate materials and intrinsic safety devices compatible for the installation of electrical equipment in Class 1, Division 2, Group C hazardous locations.

6.8 Construction QA Requirements

The Construction QA Plan describes the QA activities for constructing the Phase I IDF. QA activities will be required during construction to ensure the following:

- Firm and stable foundation system for liners.
- Stability of dikes or embankments.
- Low permeability soil liners that inhibit contaminant migration.
- Geosynthetic layers that function as either a hydraulic barrier or a drainage system, depending on intended function.
- LCRS and LDS that remove leachate and control head on the lining systems.
- The Construction QA Plan has been prepared to describe the activities that will be performed during construction of the lining system, leachate collection system, and operation layer of Cell 1 and Cell 2. The Construction QA Plan satisfies the regulatory requirements and guidance established in 40 CFR 264.19, the EPA technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA 1993), and WAC 173-303-335.

The specific physical components that the WAC requires the Construction QA Plan to address include:

- Foundations
- Dikes
- Low-permeability soil liners
- Geomembranes
- LCRS and LDS
- Final cover systems
- The WAC requires the Construction QA Plan to include the following:
- Identification of applicable units and how they will be constructed
- Identification of key personnel
- Description of inspection and sampling activities

The Construction QA Plan is intended to be implemented by an independent, qualified Construction QA certifying engineer, familiar with EPA's technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities,* as well as the Construction QA Plan. The Construction QA certifying engineer will be supported by other Construction QA representatives, as necessary, to implement the requirements in the Construction QA Plan and document the work.

The Construction QA Plan establishes general administrative and documentation procedures that will be applicable for selected activities of construction. The Construction QA Plan addresses only those activities associated with the soils, geosynthetics, and related liner and leachate collection system piping components for the Phase I IDF landfill. Other aspects of construction, such as transmission piping, utilities, concrete, and storage tanks will require QA testing and oversight. These requirements are not mentioned in the Construction QA Plan, but they will be included in future construction inspection documents, accompanying the bid-ready drawings and specifications.

6.9 Interface with Non-Critical Systems

Critical systems for the Phase I IDF include three primary design components:

- Liner systems
- LCRS
- LDS

In addition, the Phase I IDF detailed design also involves completing all design work required for an operable landfill.

Non-critical systems for the Phase I IDF include the following components:

- Entrance facilities, including entrance area, scales, and staging areas
- Administration and control facilities
- Waste delivery access road improvements to the IDF site from the WTP
- Waste treatment and staging areas
- Gates and fences
- Utilities including fire protection, process water, electrical power, or instrumentation cables

The IDF Phase I Critical Systems design has been prepared to interface with these non-critical systems that are necessary for operational readiness for the IDF. The following discussion details interface elements of the current design with these non-critical systems.

There is the potential for the DOE to procure an independent contractor to provide operation and maintenance services for the IDF. These services could also include the detailed design and construction of a portion or all of the non-critical systems for the facility. If this should be the case, careful consideration will be given to these interface elements in the development of performance criteria that will be included as part of any contract package for these services.

6.9.1 Entrance Facilities

Entrance facilities will control the flow of waste into the IDF. These facilities will provide for waste delivery, inspection, check-in, and final authorization for disposal into the IDF. Typically, the location for the entrance facilities is adjacent to the in-bound access road, prior to reaching the disposal area. Other factors that can influence their location include access to existing utilities and other operational facilities such as waste treatment, soil stockpiles, or staging areas. Based on the current configuration planned for the IDF, there will be room for entrance facilities to the south of the Phase I disposal area, along the western access road. Typically, these facilities require connection to such utilities as fire protection, power, and process water. Utility interfaces are discussed later in this section.

Design criteria and detailed design elements for the IDF entrance facilities have not been developed. The overall mission for the facility has expanded from handling just the ILAW packages to other wastes including Waste from the DBVS and LLW materials. This may require the entrance facilities to have expanded capabilities for waste load staging, inspection, verification, and scaling, prior to release for disposal into the IDF. This could impact the location selected for the entrance facilities, since complete development of the IDF to its full capacity will leave little room to the south of the southern perimeter berm for the facility (refer to Drawing H-2-830827).

This could require the entrance facilities to be located along 1st Street, if a permanent initial location is desired. Otherwise, a more mobile entrance area could be developed and relocated along with phased development of the facility.

6.9.2 Administration and Control Facilities

Administration and control facilities will provide the control center for LCRS operations and monitoring, as well as monitoring for LDS and other emergency systems (fire, power interruption, and HVAC controls). The administration building will service facility operations, including waste tracking and record keeping systems as well as provide for staff needs including office facilities, lunch room, lockers, and storage. Other functions that may take place in this facility area include equipment maintenance, an equipment and staff decontamination area, and equipment storage.

The proposed location of the administration building is shown on Drawing H-2-830827, to the north of the leachate storage and handling area (north of the IDF Phase I development area). This location provides quick access to the leachate control buildings and storage tanks, as well as good interface with existing utilities that will come from existing facilities to the east and west of the IDF. Power and control/communications cables will connect the administration building to the leachate control buildings (crest pad buildings, leachate pump buildings, and leachate storage tanks), as well as to other leachate control structures including the combine manholes and truck loading stations for Cell 1 and Cell 2. Additional utilities will service the administration building including fire protection, process water, potable water, communications, and power. Calculations for power supply to future facilities are provided in the *Integrated Disposal Facility (IDF) Detailed Design: Site Utilities Design Report*, (RPP-18515, Revision 1).

Design criteria and detailed design need to be established for the administration building. The expanded mission of the IDF may influence existing criteria that have already been determined for this facility as provided in conceptual design documents for the original ILAW W-520 Project. Modular units may be considered for this facility.

6.9.3 Waste Delivery Access Road

The waste delivery from the WTP will access the IDF from 1st Street and enter the IDF along the western perimeter of the landfill. Waste delivery from other areas will access the facility from one of three gates (810, 812, or 815) to the 200 East Area, as discussed previously in Section 1.
The Phase I access road is aligned horizontally with the proposed western berm of the complete IDF landfill. The vertical alignment of Phase I access road coordinates with the existing topography of the site between 1st Street and the Phase I landfill area, to minimize cut and fill requirements for this road construction. As such, the Phase I vertical alignment does not follow the vertical alignment of the future western perimeter berm of the landfill and will need to be modified in future expansion phases.
All-weather pavement for the Phase I road as well as for 1st Street will need to be completed as part of non-critical design. It is anticipated that pavement will be asphalt concrete pavement.

Access for waste haul vehicles will require upgrades to 1st Street to be designed as part of non-critical systems. Design criteria for this upgrade will be based on the anticipated haul vehicles and wheel loads for the various wastes to brought to the facility. From the Phase I Critical Systems design, the melter transport vehicle represents the most restrictive design condition for the road in terms of axle load and radius/grade limitations. However, there are also substantial wheel loads and larger volumes for ILAW package transport vehicles and other MLW and LLW wastes.

It should be noted that there will be a significant grade differential between the southern end of the IDF perimeter berm and the existing 1st Street road grade. The western berm climbs at a uniform 1 percent grade to the south. As such, it will have an elevation of approximately 741 feet at the southern perimeter road. The existing grade of 1st Street at the western perimeter of the IDF is approximately 734 feet, and so 1st Street will need to be raised to make this transition and keep vertical road grades at a maximum of 5 percent to accommodate the melter transport vehicles.

6.9.4 Waste Treatment and Staging

Currently, no waste treatment facilities have been planned for the IDF. Consideration of waste treatment may be necessary as part of the IDF's expanded mission to take mixed wastes and low-level wastes from both onsite and offsite sources, depending on the waste acceptance criteria that are established for the facility. Waste staging areas are associated with waste receipt and inspection activities, as mentioned previously. Staging and storage areas may also be needed for waste treatment as well. Design of non-critical facilities may need to consider development of these waste treatment and staging areas.

During Phase I operation, there is adequate area south of the Phase I landfill area for treatment and staging. Some staging also can occur within the landfill itself that offers the advantage of occurring over lined areas with leachate collection systems in place. However, as wastes are placed and cell lifts become full, staging areas may be limited until new lifts are ready for waste placement. Regulatory requirements for waste staging and storage may also impact location and operational requirements for these areas.

6.9.5 Gates and Fences

The IDF is being developed within the 200 East area of the Hanford Site, that has controlled access with a perimeter fence and access control gates (refer to Figure 1-1). As such, it is currently not anticipated that additional fencing and gates will be required for access control to the facility. However, operationally it may be determined that a perimeter fence and additional gates may be warranted for isolation of the IDF from adjacent existing facilities and, if so, these need to be designed during implementation of non-critical design components. Site standards for fences and gates would be followed for this design.

6.9.6 Site Utilities

As mentioned previously, site utilities are included in non-critical systems design. Site utilities will interface with existing utilities that service facilities in the 200 East area. As such, substantial coordination will be required to locate these utilities, determine the best interface tie-in location, and bring these to the IDF site. Key utilities that are needed for the IDF include:

- Power to buildings and operating systems, as well as to area lighting
- Communication between administration building and operating systems, as well as from the IDF to other area networks
- Fire protection water
- Process (non-potable) water for operations and facility construction
- Potable water

Power requirements for leachate control and monitoring systems have been designed during this Phase I Critical Systems design. Access vaults to power and control systems are provided outside of both crest pad buildings (shown on Drawing H-2-830858). It is anticipated that the administration building will connect at these access vaults and will provide power for system operation and an Ethernet connection for controls. Transformer design for bringing power from the site to the administration building (and to leachate control facilities) will be performed during non-critical design, as will design of the Ethernet connection and administration control systems. Calculations for power supply to future facilities are provided in the Integrated Disposal Facility (IDF) Detailed Design: Site Utilities Design Report, (RPP-18515, Revision 1).

Utility corridors need to be developed to bring these utilities to facility areas. It is recommended that these corridors be developed outside of landfill embankment areas and access roads, to allow for uninterrupted waste placement and facility operation, for future landfill phase development, for protection of liner system anchor trenches, and for protection of utilities from heavy wheel loads. In addition, the future final cover of the IDF is located over the perimeter embankments and catches existing ground at the outside toe of the embankment.

7.0 OPERATING PROVISIONS

7.1 Waste Placement

7.1.1 Introduction

To establish a baseline for design, construction, and operation of the IDF, a plan for filling the landfill cells was developed. This plan was developed mainly to ensure that landfill configuration and size as proposed for the IDF Phase I Critical Systems were adequate for safe placement of the ILAW, waste from the DBVS, and LLW, both remote handle and contact handle, that will be placed in the Phase I development. The proposed configuration and size of the IDF Phase I landfill are identified in Section 6 of this report.

The drawings that show the waste placement plan are included in Appendix D.1. This plan was based on the concept of completely filling the first lift in both cells before beginning filling of the succeeding lift. The plan represents one approach to filling the cells within the proposed configuration. It is possible that other approaches, such as proceeding to a subsequent lift before completely filling the previous lift, also are workable, but development of the plan did not consider alternative methodologies to fill the cells. Development of the plan is also based on conformance with the operational procedures identified for the Base Alternative in Appendix K of the *Conceptual Design Report for Immobilized Low-Activity Waste Disposal Facility, Project W-520* (RPP-7908, Revision 0), (CDR).

This waste placement plan is intended to meet the applicable functional criteria identified in the *System Specification for Immobilized Low-Activity Waste Disposal System* (RPP-7303, Revision 3). "As low as reasonably achievable" principals (keeping radiation exposures to as low as reasonably achievable) are embodied in the waste placement plan that was developed. Because of the area available for waste disposal in each cell, the plan provides the capability to relocate filling operations to another area within each cell, if an event occurs that causes operations to halt temporarily, placing waste packages at the current working position. This will allow waste package placement to continue while the situation that caused the operations to cease is resolved.

7.1.2 Phase I Configuration

Under the proposed configuration for the IDF Phase I, there will be two cells, identical in size. One cell will be for disposal of ILAW and waste from the DBVS; the other cell will be for disposal of LLW. This waste placement plan proposes disposal of ILAW and DBVS waste Cell 1 and disposal of LLW in Cell 2. Provisions are included for disposal of both remote handle and contact handle waste in each cell.

The configuration of the IDF Phase I development as it will exist at the completion of construction, prior to beginning filling operations, is shown in Appendix D, Drawing D.1-1. The initial operations layer, placed as part of Phase I construction, will cover the entire bottom liner and LCRS. The top of the operations layer will be level in the east-west direction and slope down at 1 percent from the south to the north. The operations layer will extend up the west, north, and east side slopes. Access to the facility will be from 1st Street along the western site boundary. An access ramp from the southwest corner of Phase I will lead down the south excavation slope from the west side to the bottom of Phase I and connect to the top of the operations layer near the south east corner of Cell 2.

7.1.3 Waste Receipts

As stated in Section 6.2, the IDF will receive ILAW and Waste from the DBVS. The volumes stated in Section 6.2 are based on waste forecast information provided by FH. The waste volume forecasts are updated by Hanford Site contractors on a regular basis. Actual waste receipt rates at the IDF will likely vary from the estimated amounts. Depending on the receipt rate of ILAW and DBVS waste versus the receipt rate of LLW, each lift of Cell 1 and Cell 2 may fill at different rates. The waste placement plan can accommodate differing rates of waste receipt because filling in subsequent lifts in each cell could be begun at different times as soon as the prior lift was complete. The cell that has the higher waste receipt rate will fill faster than the other cell and will determine the time when subsequent phases of development will need to begin so that additional disposal capacity is available when it is needed.

7.1.4 General Waste Placement Procedures

The discussion of waste placement in this plan is based on placement of the uniform height ILAW packages using remote handle. Some adjustments may need to be made for the variable height LLW containers and for contact handle waste, but in general, the waste placement concept will be the same for all types of waste.

The configuration of IDF Phase I provides a height sufficient for four layers of ILAW packages, each covered with one meter of operations layer soil to provide shielding to operations personnel during waste package placement. LLW, which will be in variable height containers, can be accommodated within each of these four lifts. However, in some cases the LLW containers may exceed the lift height and, therefore, will not be completely covered by placement of the operations layer soil. In these cases, it may be necessary to mound cover soil around the individual projecting LLW containers to provide sufficient cover for shielding until they are completely covered by subsequent lifts.

Each lift will contain multiple ILAW package arrays that span the width of each cell. The packages will be placed in close-packet hexagonal arrays, with placement tolerance averaging 10 centimeters (4 inches) center to center. As the packages are placed in the cell, the array will proceed along the width of the cell. The earth cover will proceed shortly behind the advancing package array, the distance behind the front package limited by the repose slope of the fill soil. The array width (number of columns of packages) will be limited according to the amount of radiation generated by the total number of packages that can be exposed. The CDR indicates that even at some distance from the advancing array, the dose rate becomes a concern when the array approaches more than ten or twelve packages in width.

Off-loading of the ILAW packages and other waste containers will take place in the cell. A standard, manually operated, rubber-tired crane will off-load packages, move temporary shielding walls (concrete blocks), and place the interstitial fill between the packages using a hopper. In the CDR, the total weight of the shielding bell, package grapple, load cell, hooks, and other rigging is estimated at 20 metric tons (23 tons). The crane, as identified in the CDR, will be a Grove GMK 5100, a 108 metric ton (120 ton), rough terrain rubber-tired crane with a telescoping boom and a maximum reach of 15 meters (50 feet), with a load of 20 metric tons (23 tons). Pad loads could exceed 55 metric tons (60 tons) when placing an ILAW package at the maximum allowable reach. Dunnage required under each outrigger pad of the crane for lifts of this size has been determined to be 60 square feet, when operating directly on the base operations layer at its point of minimum thickness over the bottom liner system. Dunnage requirements for subsequent lifts would be less, but have not been determined. Refer to Section 5.5.5 and Appendix C.5.e of this Design Report for dunnage requirement calculations.

7.1.5 Moveable Shielding Wall

With off-loading operations in close proximity to the advancing package array, a moveable shielding wall will be set up between the crane and transporter operations and the placed packages (CDR, Drawing No. ES-W520-BASE). With the 15-meter (50-foot) maximum reach of the crane, the shield walls will have to be moved after every five rows of packages are placed. For a ten-package-wide-array, the wall will need to be relocated after fifty packages have been deposited, or about every eight days during Phase I.

To prevent the crane crew from receiving a high exposure rate, a new shield wall will be erected before the first shield wall is removed. A remote grappling system will be required to prevent rigging of the previously placed shield wall from causing high dose rates to operations personnel. Even then, the amount of time it will take to move the wall is estimated in the CDR to be 26 hours, four to five shifts, or a little less than two days when operating a full 24 hours per day.

An alternative to the movable shielding wall is to use contact handle waste to construct the shielding wall and to leave it in place after placement of each ILAW array rather than moving it. This can reduce operations labor and expenses. It can also result in the use of less cover soil because the space between the package arrays will be partly filled with contact handle waste, rather than with all soil.

This alternative needs to be considered further when developing the operations plan for operating the disposal facility.

7.1.6 Typical Array Size

The moveable shielding wall set up between the crane and transporter operations and the placed package configuration will limit the proximity of package placement to between 15 meters (50 feet) and 7.5 meters (25 feet) of the crane. The 7.5 meters (25 feet) usable range of the crane reach, working over the shielding wall, and the ten or twelve maximum package width (because of dose rate limitation) determines the nominal array size that can be placed by the crane from a single set point. The 1.22 meters (4 feet) diameter ILAW packages will be staggered in the array to minimize the space between the packages. A column that is five packages deep can fit within the 7.5 meters (25 feet) available range of the crane reach while working over the shield wall. A width of ten packages is within the reach of the crane and is less than the allowable limits for the dose rate. Allowing for a 10 centimeters (4 inches) average tolerance in package placement, the five-row by ten-package-wide array is roughly 6 meters (20 feet) deep by 13.3 meters (44 feet) wide. A typical array is shown in Appendix D, Drawing D.1-1.

7.1.7 Cover Soil

Prior to the shield wall being relocated, the crane will place interstitial soil material between the packages, using a hopper. The filling operation is expected to take about one shift, according to the CDR, using up the balance of the two days needed to move the shield wall. To make up the time spent moving the shield wall and placing the interstitial fill soil, the average rate of package placement will have to be increased to seven packages per day for five days, according to the CDR.

While the shield wall is being relocated, a soil cover will be placed over the packages from on top of the lift of previously placed packages. Dump trucks will drive over the previously covered portion of the array and back up to near the edge of the packages that are still exposed and dump a load of fill soil for spreading by a bulldozer. The soil will be spread over the top of the top and exposed side of the array. The side slope from soil, cascading off the top, will be formed in no less than 1.5 H: 1V for reasons of safety, and will use approximately a 5-meter (16-foot) wide space between lines of arrays. Approximately 300 cubic meters (400 cubic yards) of soil will be required to cover the top and side of the five-row-deep by ten-package-wide array. The cover soil will be held back from the advancing end of the array so that the toe of the cover soil does not extend beyond the outer package in the array. This will allow the next array to be placed in close proximity to the previous array. After the bulldozer spreads the soil to a somewhat uniform 1-meter-plus thickness over the packages, a sheepsfoot-style compactor will make several passes to consolidate the fill soil. The cover soil effort will take approximately 12 hours or two shifts, as estimated in the CDR, and will take place at the same time that the portable shield wall is being relocated.

7.1.8 Failed Melter Disposal Area

(Note: Disposal of failed melters is not permitted at this time by this permit.)

Failed melters can be disposed of as MLLW in Cell 1. A failed melter disposal area is provided on the bottom of Cell 1 at the southern toe of the waste lifts. Disposing of the failed melters in this area would eliminate placing them within the lifts along with the ILAW packages and other MLLW.

7.1.9 Access Ramps

Two 30-foot wide access ramps will be built into the south slope of the waste lifts to accommodate the movement of transport vehicles and equipment from one lift to the next. A third access ramp will be built through the north shine berm onto the top of the third lift to accommodate transport vehicles and equipment during the construction of Phase II, when the access ramp leading down the south excavation slope to the bottom of Phase I will be removed.

The access ramp into Cell 1 and the access ramp from the north side would have a maximum slope of 5 percent to accommodate failed melter transporters, if it becomes necessary to dispose of the melters in the waste lifts rather than in the designated area at the bottom of Cell 1. The access ramp into Cell 2 would have a maximum slope of 8 percent that would accommodate the ILAW, DBVS containers, and LLW waste transporters. The access ramps at the bottom of Phase I would have minimum outside turning radii of 75 feet, to accommodate the failed melter transporters. The dimensions of the access ramps provide flexibility to accommodate the various waste haul vehicles that could use the ramps.

7.1.10 Filling Lift 1

Filling of remote handle ILAW and DBVS waste in Cell 1 will begin in the northwest corner and proceed to the southeast. Filling of remote handle LLW in Cell 2 will begin in the northeast corner and proceed to the southwest. Filling of contact handle LLW will begin in the northwest corner of Cell 2 and proceed southeast (see Appendix D, Drawing D.1-2). This filling approach places the remote handle wastes farthest apart from each other, with contact handle wastes between them, and eliminates the need for additional shielding provisions that would be necessary if the two remote handles wastes were located adjacent to each other. This filling approach will be continued in the three subsequent lifts.

Nearly all of Lift 1 can be filled with the crane and transporters, operating from the top of the first operations layer. A 5-meter (17-foot) wide separation will be maintained between Cell 1 and Cell 2 to separate the ILAW and DBVS waste from the LLW. This separation area will be filled with soil. Using a low permeability soil in this area will maximize separation of leachate between the two cells. Two access lanes (ramps) will be maintained into the cells for transporter access. The transporters can turn around within the cells until the packages are within 7.5 meters (25 feet) of the area needed for the unloading operations.

Before the space for filling Lift 1 from the top of the first operations layer is consumed, the two access ramps will be extended with soil and contact handle waste to the top of Lift 1. The crane and transporters will go to the top of Lift 1 and will finish placing the remainder of the Lift 1 waste packages from the top (see Appendix D, Drawing D.1-3). At this point, it will also be possible to begin using the failed melter disposal area (also shown on Drawing D.1-3).

7.1.11 Filling Lift 2

Lift 2 will be filled similarly to Lift 1 (see Appendix D, Drawing D.1-4). This filling approach will continue the pattern that was established in Lift 1. Nearly the entire lift can be filled with the crane and transporters operating on the top of Lift 1. The 5-meter (17-foot) wide soil-filled separation will be maintained between Cell 1 and Cell 2 to separate the ILAW and DBVS waste from the LLW. The two access ramps will be maintained into both cells for transporter access. The transporters can turn around within the cells until the packages are within 7.5 meters (25 feet) of the area needed for the unloading operations. Before the space for filling Lift 2 from the top of Lift 1 is consumed, the two access ramps will be extended with soil and contact handle waste to the top of Lift 2. The crane and transporters will go to the top of Lift 2 and will finish placing the remainder of the Lift 2 waste packages from the top (see Appendix D, Drawing D.1-5).

7.1.12 Filling Lift 3

Lift 3 will be filled similarly to Lift 2 (see Appendix D, Drawing D.1-6). Nearly the entire lift can be filled with the crane and transporters operating on the top of Lift 2. The 5-meter (17-foot) wide soil-filled separation will be maintained between Cell 1 and Cell 2 to separate the ILAW and DBVS waste from the LLW. Two access ramps will be extended into the cells for transporter access. The transporters can turn around within the cells until the packages are within 7.5 meters (25 feet) of the area needed for the unloading operations. Before the space for filling Lift 3 from the top of Lift 2 is consumed, the two access ramps will be extended with soil and contact handle waste to the top of Lift 3. The crane and transporters will go to the top of Lift 3 and will finish placing the remainder of the Lift 3 waste packages from the top (see Appendix D, Drawing D.1-7).

7.1.13 Filling Lift 4

Lift 4 will be filled similarly to the previous three lifts, but with a few differences (see Appendix D, Drawing D.1-8). Most of the lift can be filled with the crane and transporters operating on the top of Lift 3, using the access ramps from the south. However, only the easterly access ramp from the south is planned to be extended to the top of Lift 4 for transporter access. The westerly access ramp from the south will not be extended because, as shown on Appendix D, Drawing D.1-9, it would reach the top of Lift 4 too close to the west side slope to accommodate an adequate turning radius for the transport vehicles. The access ramp will be blocked by waste placement in Cell 1. However, with some minor adjustment in its location and/or increase in its slope, it will be possible to extend the access ramp into Cell 1, if desired. Also, at some point during the filling Lift 4, construction for Phase II to the south will begin, and the access road from the south will be removed from service.

Prior to the westerly access ramp becoming blocked with waste and the access road from the south removed for construction of Phase II, a third access ramp will be constructed from the north down onto the top of Lift 3 to provide additional access. This access ramp will maintain separation between Cell 1 and Cell 2, to separate the ILAW and DBVS waste from the LLW. The transporters can turn around within the cells until the packages are within 7.5 meters (25 feet) of the area needed for the unloading operations.

Before the space for filling Lift 4 from the top of Lift 3 is consumed, the easterly access ramp will be extended with soil and contact handle waste to the top of Lift 4, and the access ramp from the north will be graded out onto the top of Lift 4. The crane and transporters will go to the top of Lift 4 and will finish placing the remainder of the Lift 4 waste packages from the top (see Appendix D, Drawing D.1-9). Completion of Lift 4 will end the filling operations in Phase I. The configuration at the end of Lift 4, prior to placement of the final cover system, is shown on Appendix D, Drawing D.1-10.

7.1.14 Transitioning Between Lifts

As the available operating space in a lift gets smaller, operations efficiency will decrease to a point where it will become necessary to move part of the operations to the next lift before the active lift is completed. This will allow completion of each lift, using selected waste that will be easier to handle in the remaining space available on the lift. An example of this would be to use only contact handle waste to complete the filling of each lift while operating on the top of the lift that is being completed (see Appendix D, Drawings D.1-3, -5, -7, and -9) and sending all remote handle waste into the next lift.

7.1.15 Planning for Phase II and Operations During Phase II Construction

Phase II will need to be constructed and ready for operations sufficiently ahead of completion of filling operations in Lift 4 of Phase I to allow a smooth transition without operational constraints. Planning, design, and construction of Phase II may require several years. Phase II should be planned to be ready for operation at least six months, and preferably one year or more, before Lift 4 in Phase I is anticipated to be completed. This will provide a reasonable margin for changes in the incoming waste quantities and other variables while still having Phase II ready for operation, prior to reaching capacity in Phase I.

While Phase II is under construction, the access road on the west will be out of service for a period of time and the access ramp on the south into Phase I will be removed. During this time, it will be necessary for all waste transport vehicles to enter Phase I, using the access ramp on the north side. As currently designed, some access roads on the west and north sides of Phase I that normally would be used to reach the north access ramp might not accommodate all of the transport vehicles. In particular, the berm access road on the west side of Phase I and the access roads around the leachate storage tanks on the north do not have widths and turning radii as large as required by the waste transport vehicles. These roads would have to be widened and their turning radii increased to meet the requirements for transport vehicles, particularly the failed melter transporters.

7.2 Operational Interfaces

Operations and maintenance procedures will be prepared in the future as a separate project. These procedures will address operations, monitoring, and maintenance activities for the IDF.

This section of the Design Report presents important operational interfaces that have been identified by the design team. These interfaces should be considered during preparation of the operation and maintenance procedures. The interfaces are grouped by three categories–landfill excavation, liner system, and leachate handling system.

7.2.1 IDF Landfill Excavation and Related Subsystems

Operational interfaces for the landfill excavation and related subsystems include the following:

- Due to the containerized nature of the waste, the landfill is designed to be filled in a bottom-up fashion in four or more layers. The number of layers will depend on waste package size. Some waste packages may be larger in dimension than the ILAW packages. Operational procedures should be developed to accommodate various package sizes and their placement.
- Clean fill placement between waste packages must be done to minimize the potential for future consolidation and potential subsidence.
- Operations layer on side slopes of IDF will be monitored for material loss due to wind and water erosion. Lost material should be replaced. Annual application of spray-on type soil stabilization material to exposed areas of Phase I IDF should be considered.
- Shine berms should be monitored for erosion and height and should be repaired as necessary. Erosion control matting on the berm will be maintained and repaired or replaced if damage occurs.
- Stormwater control facilities should be maintained annually. Maintenance would include debris removal from the ditches and application of weed control. Periodically, if capacity of infiltration areas is diminished due to collection of fines, fines removal will be necessary. To maintain infiltration capacity, no other vehicle access should be allowed into these areas.
- Stormwater accumulation in the in-cell excavation infiltration area should be visually monitored. Pumping of the area may be necessary if accumulation becomes significant (near liner levels) in wet weather seasons. Periodically, if capacity of infiltration areas is diminished due to collection of fines, fines removal will be necessary. To maintain infiltration capacity, no other vehicle access should be allowed into these areas.
- Due to the heavy wheel loads on the access roads and ramps, gravel surfacing will be maintained with regular maintenance. Maintenance activities may include addition of more top course material, and grading and compaction of this material.
- Active faces of stockpiles will require periodic application of spray-on soil stabilization material.

7.2.2 IDF Liner System

Operational interfaces for the lining system include the following:

- Only equipment with ground pressures less than 4,400 lb/ft should be used for construction and maintenance on the side slopes, when operating directly on the operations layer. Bulldozers or other equipment may operate on the side slopes until a rain event in excess of 0.15 inches per hour occurs. In that event, equipment should be kept off the side slope (directly on the operations layer) and should not be permitted to operate on slopes until two hours after the end of the rainfall event. The precipitation event applies to both the lined slopes and the unlined slopes at the southern end of the Phase I cell.
- For equipment on ramps, equipment should be kept a minimum of 2 feet away from the edge of ramps, to avoid localized sloughing of the ramp edges.

- When operating equipment or placing waste on the operations layer above the lining system, care should be taken to avoid damaging the liner. Special care will be necessary for equipment operation on the side slopes.
- Any loads placed on the surface of the first operations layer must be examined to verify that they do not create loads on the lining system in excess of the allowable GCL bearing capacity. As an example, different types of waste other than canisters should be examined as the waste plan is more fully developed. Care should also be taken to avoid impact loading, such as dropping a canister.
- For static loading (such as for a barrier wall), refer to the discussion in Section 5.2 and Appendix C.2.
- For operational/equipment loading, refer to the discussion in Section 5.5.5 and Appendix C.5.e to determine applicable load limits and crane dunnage requirements.

The waste plan, as it is developed, should be followed for placement and density requirements. Any revisions to the proposed waste filling plan (discussed in Section 7.1) should be reviewed by the design engineer, to evaluate impacts on the waste/fill global stability analyses (Section 5.1.3 and Appendix C.1.c).

As part of the waste/fill global stability analyses, the waste mass was considered internally stable for this design effort. Internal waste mass stability is a function of the waste filling approach. There are numerous options available to stabilize the waste through operational methodologies, such as providing a greater soil buttress on the open 3:1 south slope. During subsequent design phases, the internal stability of the waste should be evaluated in conjunction with the waste filling plan.

7.2.3 IDF Leachate Handling System

Operational interfaces for the leachate handling system include the following:

- Coordinate with Liquid Effluent Retention Facility (LERF) for leachate hauling and removal of leachate from tanks to satisfy the 90-day accumulation period (Treatment capacities at LERF and leachate flows for critical periods should also be coordinated. See Section 5.9.2.4 for additional leachate hauling constraints.)
- Use leak detection history for leachate storage tanks, during the operation of IDF, to manage and plan for replacement of tank liner system and temporary storage required during its replacement.
- Periodic preventative inspection and maintenance for all rotating equipment should be scheduled.
- ~~For leachate tanks floating covers, rain or snow will need to be pumped off with the manufacturer-included sump pump (mounted on side of tank). Water should not be allowed to accumulate except at the perimeter of the floating cover. Excessive water may prevent vent operation and cause mixing between precipitation water and leachate on top of the cover.~~
- An adequate store of critical spare electrical and mechanical parts should be maintained.
- All valves should be exercised at least annually.
- A small "contractor-type" trash pump with hose should be kept on hand that can be used to pump from the leak detection chamber within the combined sump to its inner sump.
- Periodically, test operation of the combined sump pump should be done.
- Annual testing of all leachate pumps for proper operation should be scheduled.
- Regular verification of level transducer calibration in cells should be done.
- Prior to winter months, proper operation of all heat tracing system should be checked.
- Periodic testing of all control relays, switches and contacts should be scheduled.
- Additional operational interface items will be developed, based on completion of design of the control system for the leachate handling system. This will be part of the IDF administration building design.
- Maintenance should be provided in accordance with manufacturer's recommendations.

7.3 Leakage Response Action Plan

WAC 173-303-665(9) regulations require the owner of the operator of a landfill unit to have an approved Response Action Plan (RAP) before receipt of waste. The RAP is a site-specific plan that establishes actions to be taken if leakage through the upper (primary) lining system of a landfill exceeds a certain rate. The intent of the RAP is to assure that any leachate that leaks through the primary lining system will not migrate out of the landfill into the environment.

A key element of the RAP is the ALR, a threshold value which triggers the responses described in the RAP, but below which no special actions are required. Because landfill liner systems have not yet been perfected, a small amount of leakage through the primary liner generally occurs, despite the use of best available materials, construction techniques, and QA procedures. (This leakage is collected by the LDS system and removed from the landfill.) Hence, the ALR is set at some level higher than normally expected leakage rates to serve as an indicator that the primary lining system is not functioning as expected. Exceeding the ALR may reflect serious failure of the primary lining system and indicates the need for investigation and possibly corrective action while the problem is still manageable.

This RAP has been prepared in accordance with requirements of WAC 173-303-665(9). The requirements for determining the ALR are contained in WAC 173-303-665(8) and EPA guidance document, *Action Leakage Rates for Leak Detection Systems* (EPA 1992a).

The following sections establish the ALR and discuss response actions to be taken if the ALR is exceeded.

7.3.1 Action Leakage Rate

Section 5.11 provides a detailed discussion of the analysis to determine the ALR into the LDS for the IDF. Based on this analyses, the ALR for each IDF cell is 206 gallons per acre per day, or approximately 1,800 gallons per day per cell (each cell area is approximately 8.5 acres). This value includes a factor of safety of 2 in accordance with EPA guidelines (EPA 1992b). It is also much lower than the LDS pump capacity. Details of the calculation are presented in Appendix C.10.

In accordance with WAC 173-303-665(8)(b), the flow rate used to determine if the ALR has been exceeded will be calculated as the average daily flow rate into the sump, expressed as gallons per acre per day over a seven-day period (unless Ecology approves a different calculation). This calculation will be performed on a weekly basis during the active (operational) life of the landfill, and monthly after the landfill has been closed. Post-closure frequency may be reduced if only minimal amounts of leachate accumulate in the LDS sump. As outlined in WAC 173-303-665(4)(c)(ii), during post-closure monitoring, if the liquid level in the LDS sump stays below the pump operating level for two consecutive months, monitoring of the amount of liquid in the LDS sumps can be reduced to at least quarterly. If the liquid level in the LDS sump stays below the pump operating level for two consecutive quarters, monitoring of the amount of liquid in the LDS sumps can be reduced to at least semiannually. Pump operating level is defined as a liquid level approved by Ecology, based on pump activation level, sump dimensions, and level that minimizes head in the sump.

7.3.2 Response Actions

WAC 173-303-665(9) lists several required actions if the ALR is exceeded. In the event that the ALR is exceeded, DOE will:

- Notify Ecology in writing of the exceedance within 7 days of the determination.
- Submit a preliminary written assessment to Ecology within 14 days of the determination, as to the amount of liquids, likely sources of liquids, possible location, size, cause of any leaks, and short-term actions taken and planned.
- Determine, to the extent practicable, the location, size , and cause of any leak.

- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed.
- Determine any other short-term and longer-term actions to be taken to mitigate or stop any leaks.

Within 30 days after the notification that the ALR has been exceeded, submit to Ecology the results of the analyses specified in bullets 3, 4, and 5 of this section, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the LDS exceeds the ALR, the owner or operator must submit to the regional administrator a report summarizing the results of any remedial actions taken and actions planned.

If the ALR is exceeded, the DOE will submit the required notifications to Ecology, as stated above. The EPA will also receive copies of this confirmation.

The leachate will be analyzed for chemical compounds and radionuclides. If the analytical results indicate that these constituents are present, and if the constituents can be traced to a particular type of waste stored in a known area of the landfill, then it may be possible to estimate the location of the leak. However, because the waste will meet land disposal restrictions, it will contain no free liquids and will be stabilized or solidified. In addition, the canister(s) or other type of waste package(s) may not undergo enough deterioration during the active life of the landfill to permit escape of its contents. For these reasons, it is possible that the leachate may be clean or the composition too general to indicate a specific source location.

If the source location cannot be identified, large-scale removal of the waste and operations layer to find and repair the leaking area of the liner would be one option for remediation. However, this procedure risks damaging the liner. In addition, waste would have to be handled, stored, and replaced in the landfill. Backfill would need to be removed from around the waste packages to accomplish this. If the waste packages are damaged during this process, the risk of accidental release may be high. For these reasons, large scale removal of waste and liner system materials is not considered a desirable option and will not be implemented except as a last resort.

The preferred options for remediation include covers and changes in landfill operating procedures. The preferred alternative will depend on factors such as the amount of waste already in the landfill, the rate of waste receipt, the chemistry of the leachate, the availability of other RCRA-compliant disposal facilities, and similar considerations. Hence, at this time no single approach can be selected. If the ALR is exceeded, potential options will be evaluated prior to selecting a remediation process. If necessary, an interim solution will be implemented while the evaluation and permanent remediation is performed. Examples of potential approaches include the following:

- The surface of the intermediate soil cover over the waste could be graded to direct runoff into a shallow pond. The surface would then be covered with a discardable, temporary geomembrane (e.g., 30-mil PVC or reinforced polypropylene). Precipitation water would be pumped or evaporated from the pond and would not infiltrate the waste already in the landfill. Waste packages would be placed only during periods of dry weather and stored temporarily at other times. This type of approach would also be used, if necessary, to reduce leakage during the time immediately after the ALR was exceeded, while other remediation options were being evaluated.
- If the landfill was nearly full, partial construction of the final closure cover might be an option. This would reduce infiltration into the landfill and possibly the leakage rate, if the cover were constructed over the failed area.
- A layer of low-permeability soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second “primary” liner higher in the landfill. This new liner would intercept precipitation and allow its removal.

- A rigid-frame or air-supported structure could be constructed over the landfill to ensure that no infiltration occurred. Although costly, this approach might be less expensive than constructing a new landfill.

In general, the selected remediation efforts would be those that are easiest to implement, with more difficult or expensive options to be applied only if earlier approaches were not satisfactory.

8.0 REFERENCES

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INTEGRATED DISPOSAL FACILITY
APPENDIX 4A – SECTION 3
CRITICAL SYSTEMS DESIGN DRAWINGS

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
03/31/2008	

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APPENDIX 4A - SECTION 3
CRITICAL SYSTEMS DESIGN DRAWINGS

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APPENDIX 4A - SECTION 3
CRITICAL SYSTEMS DESIGN DRAWINGS

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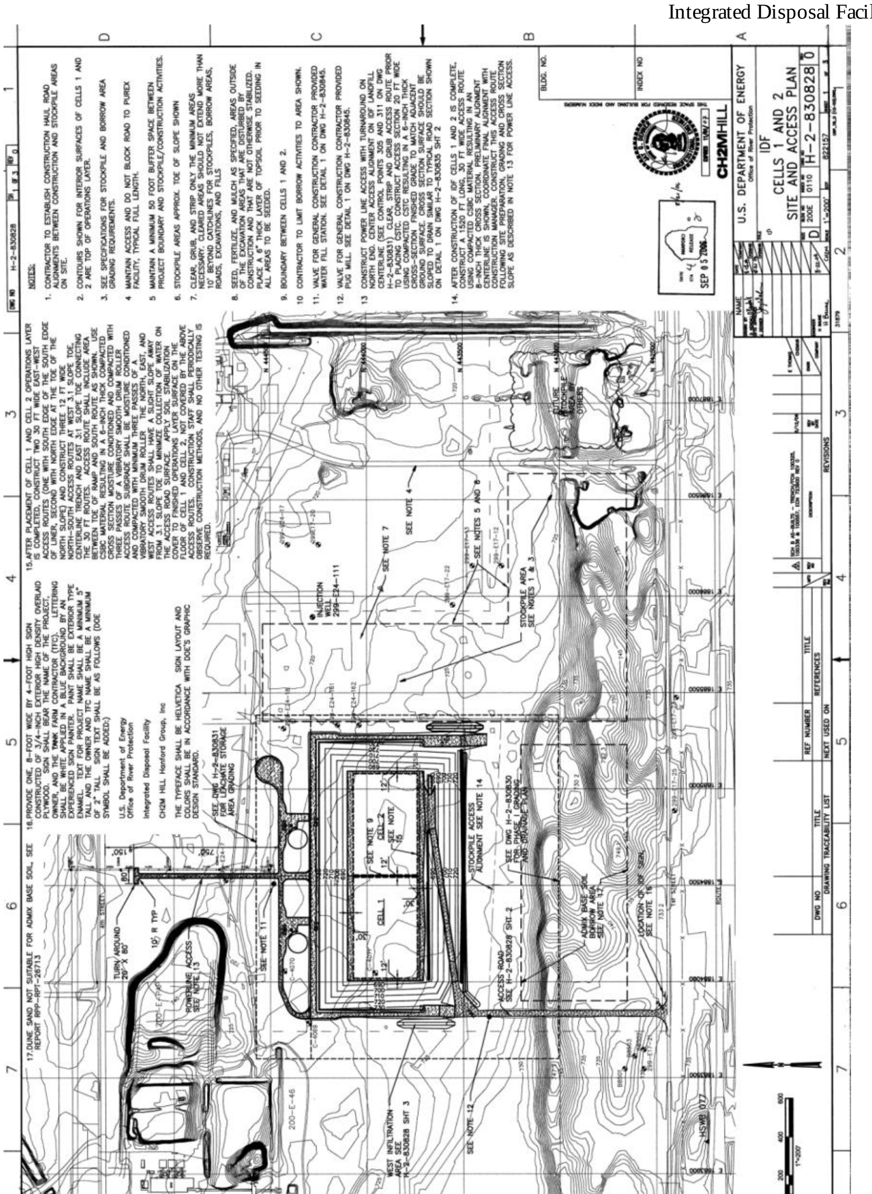

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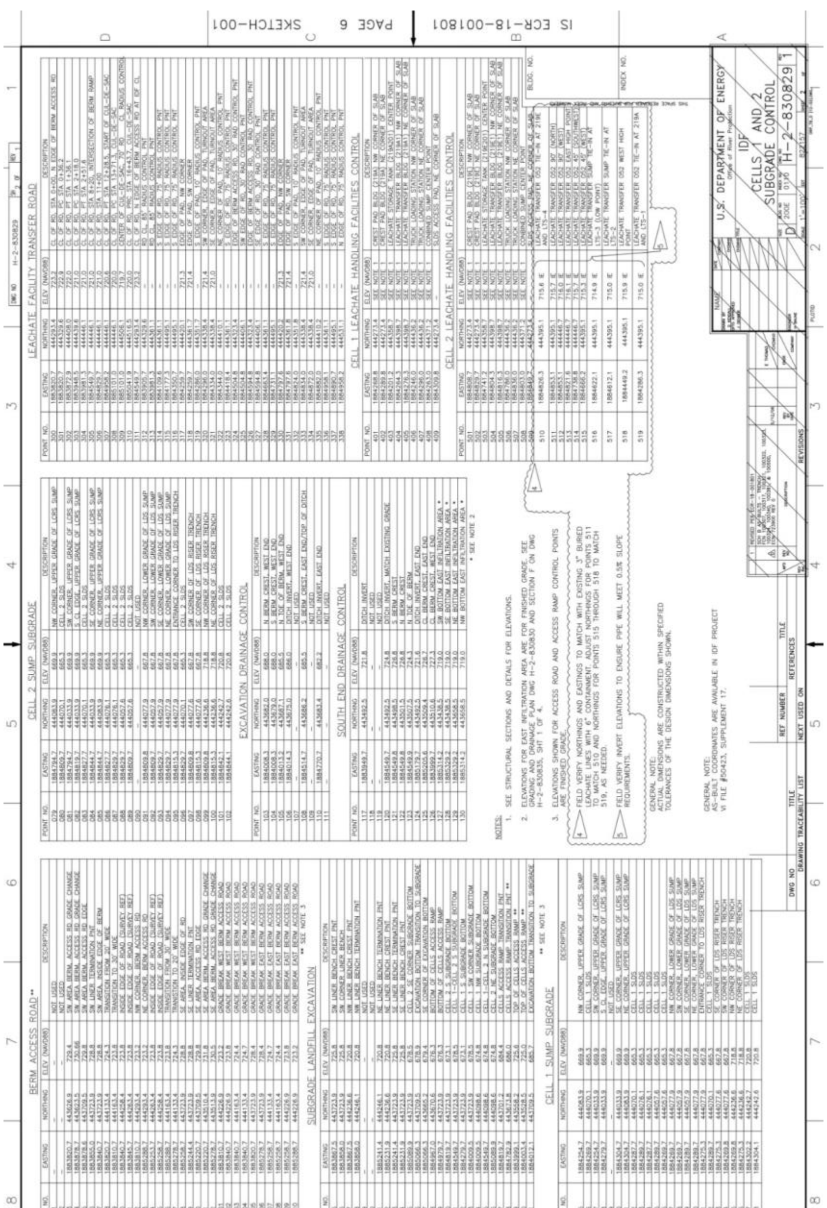

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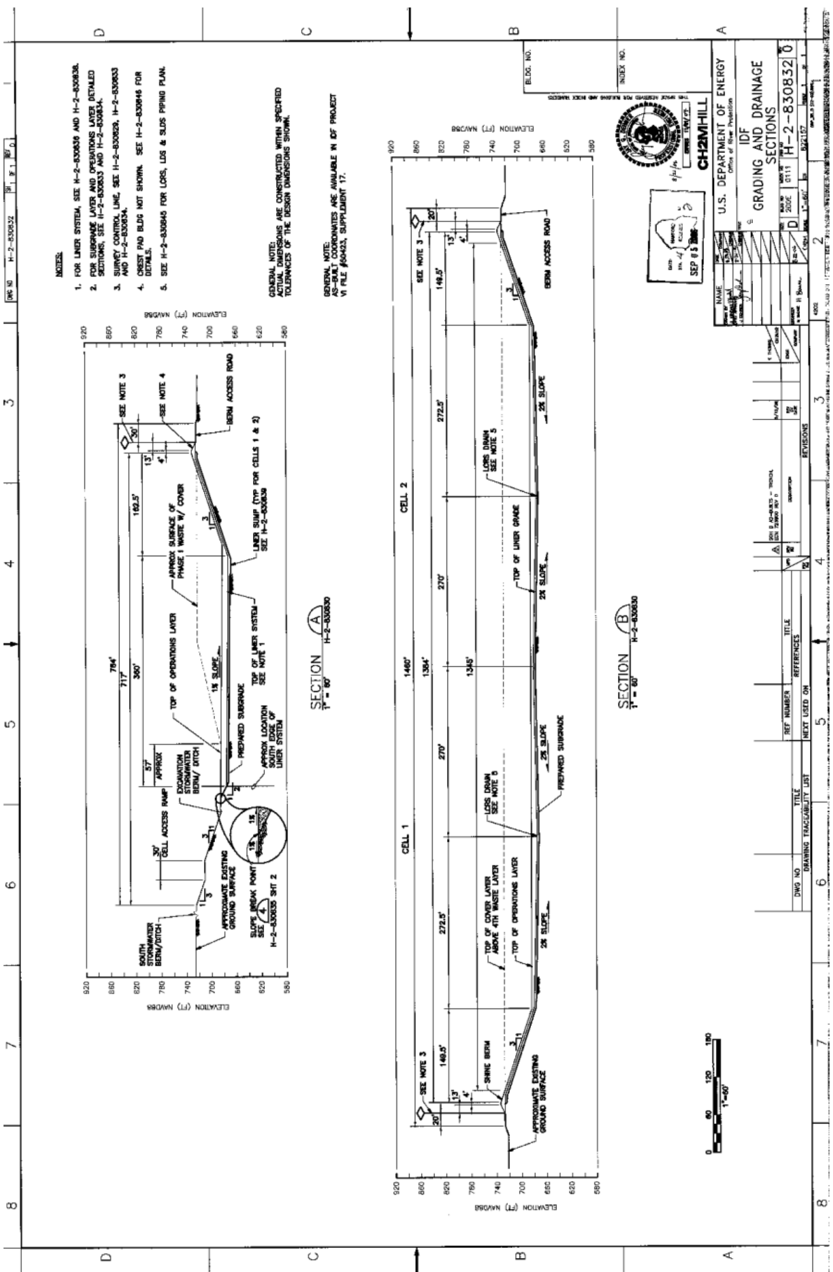

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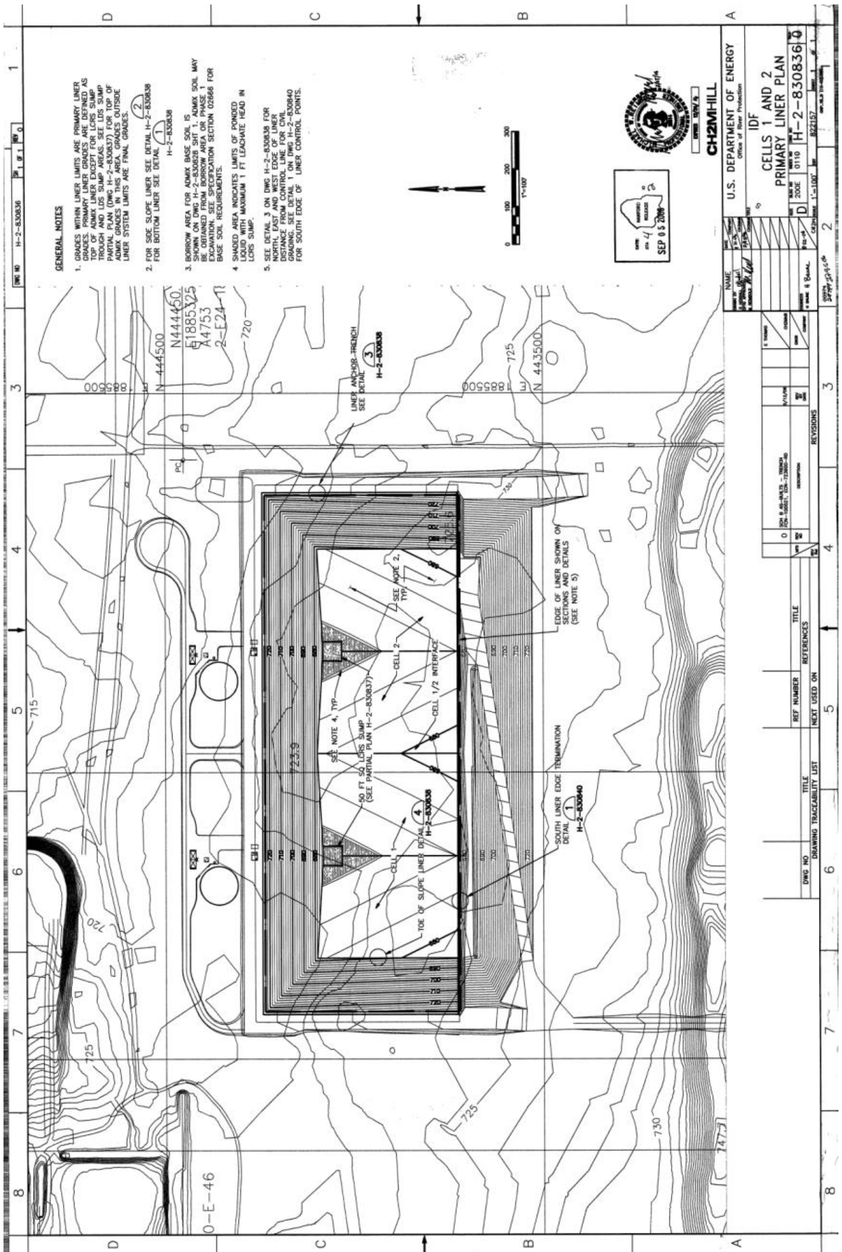

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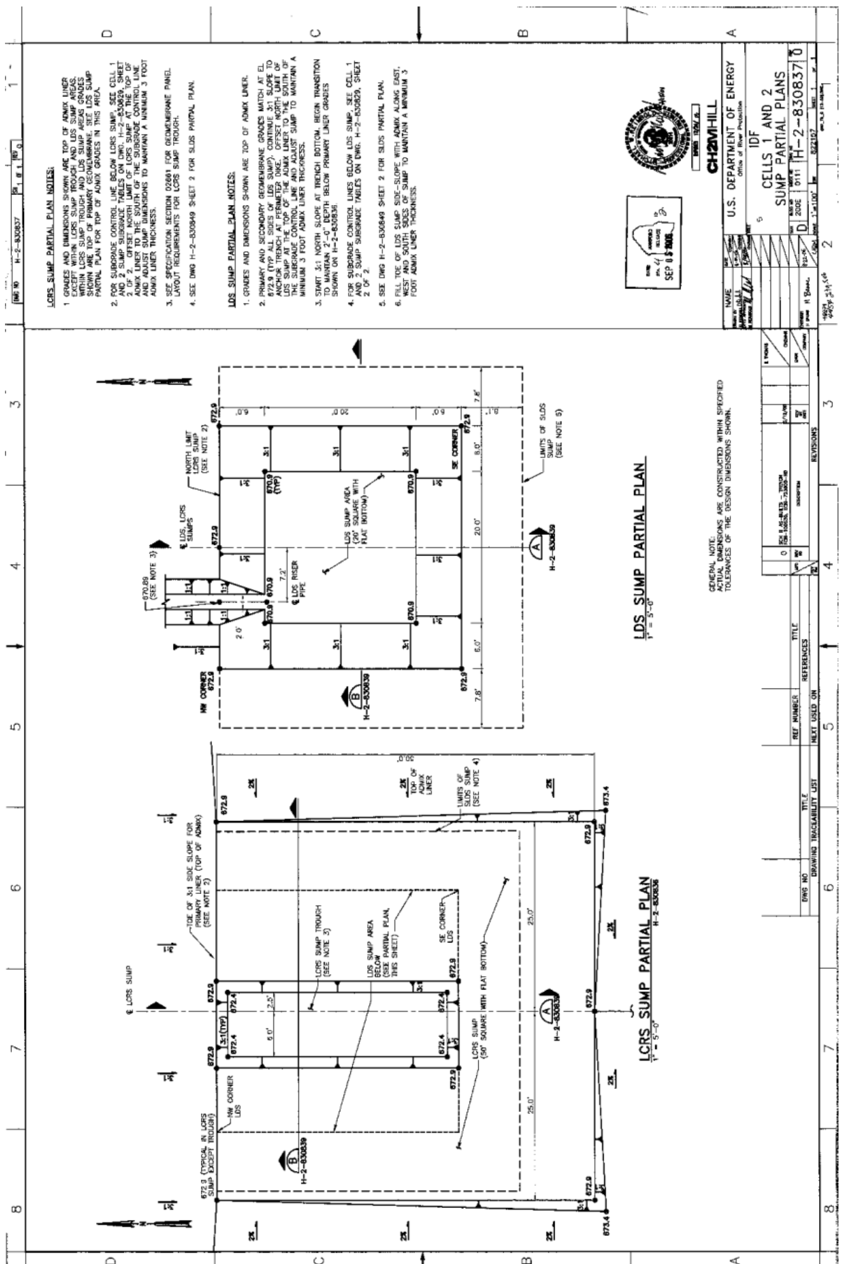

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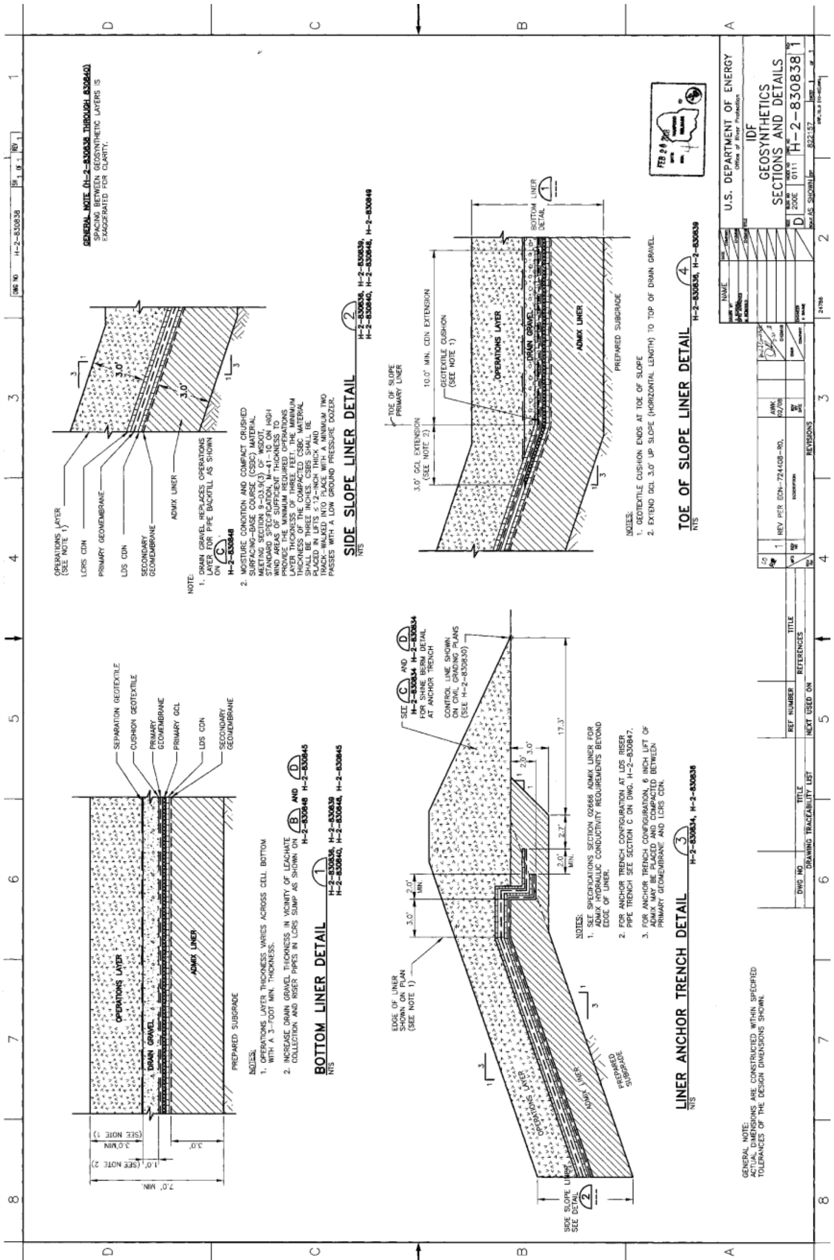

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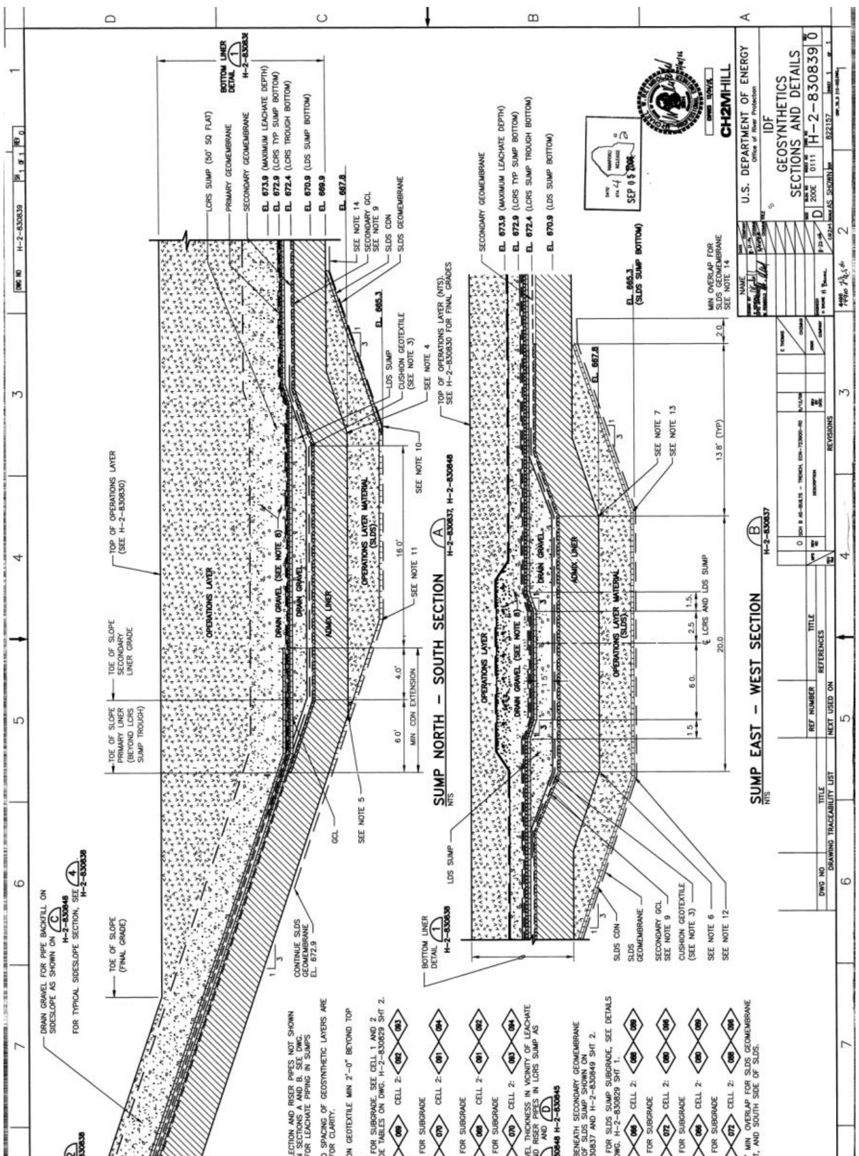

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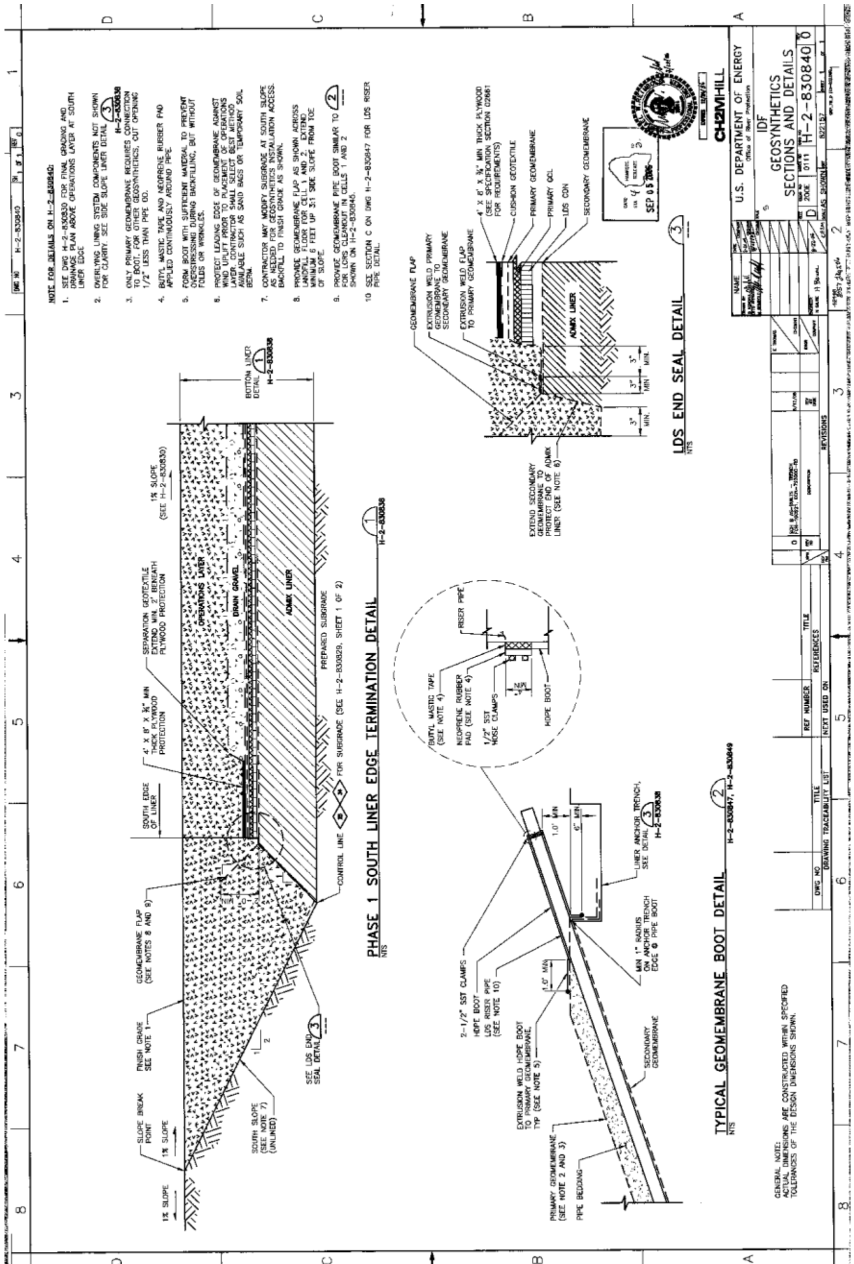

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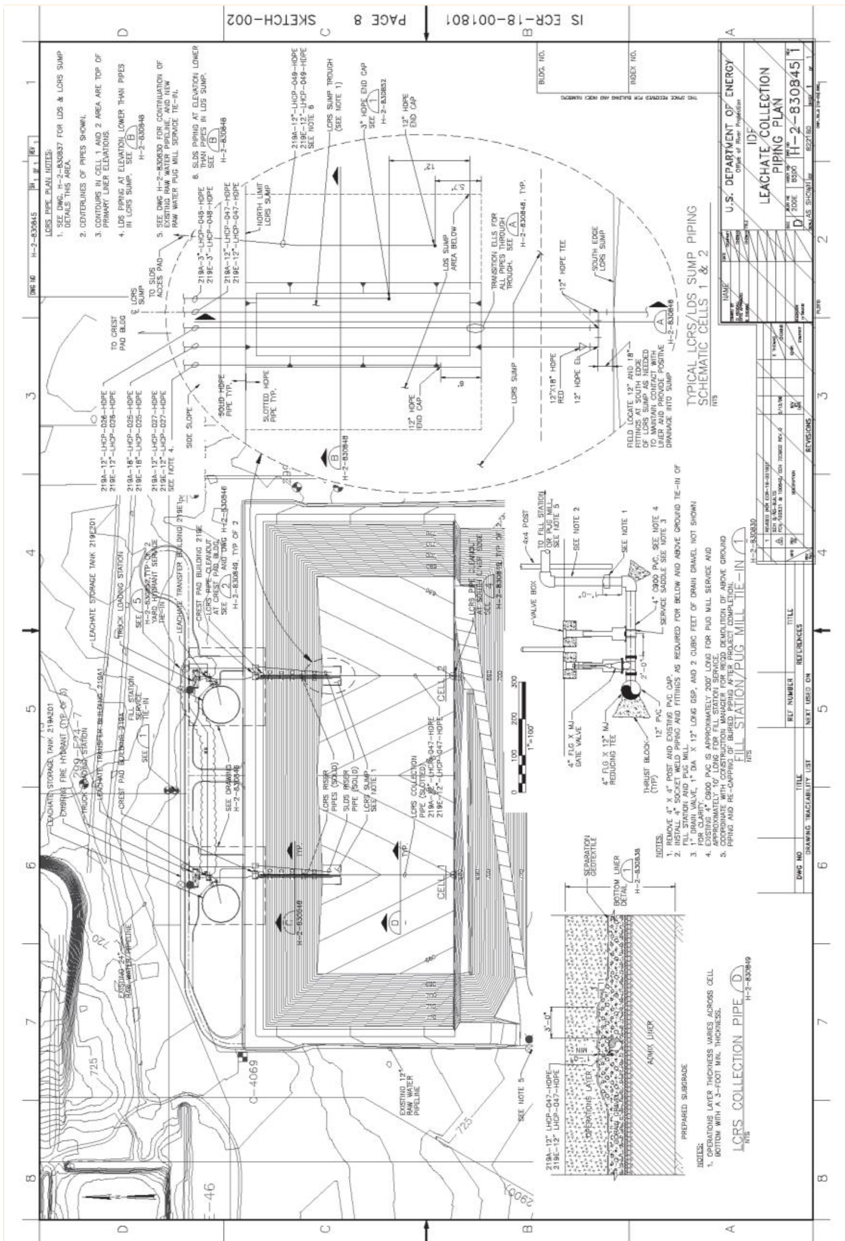

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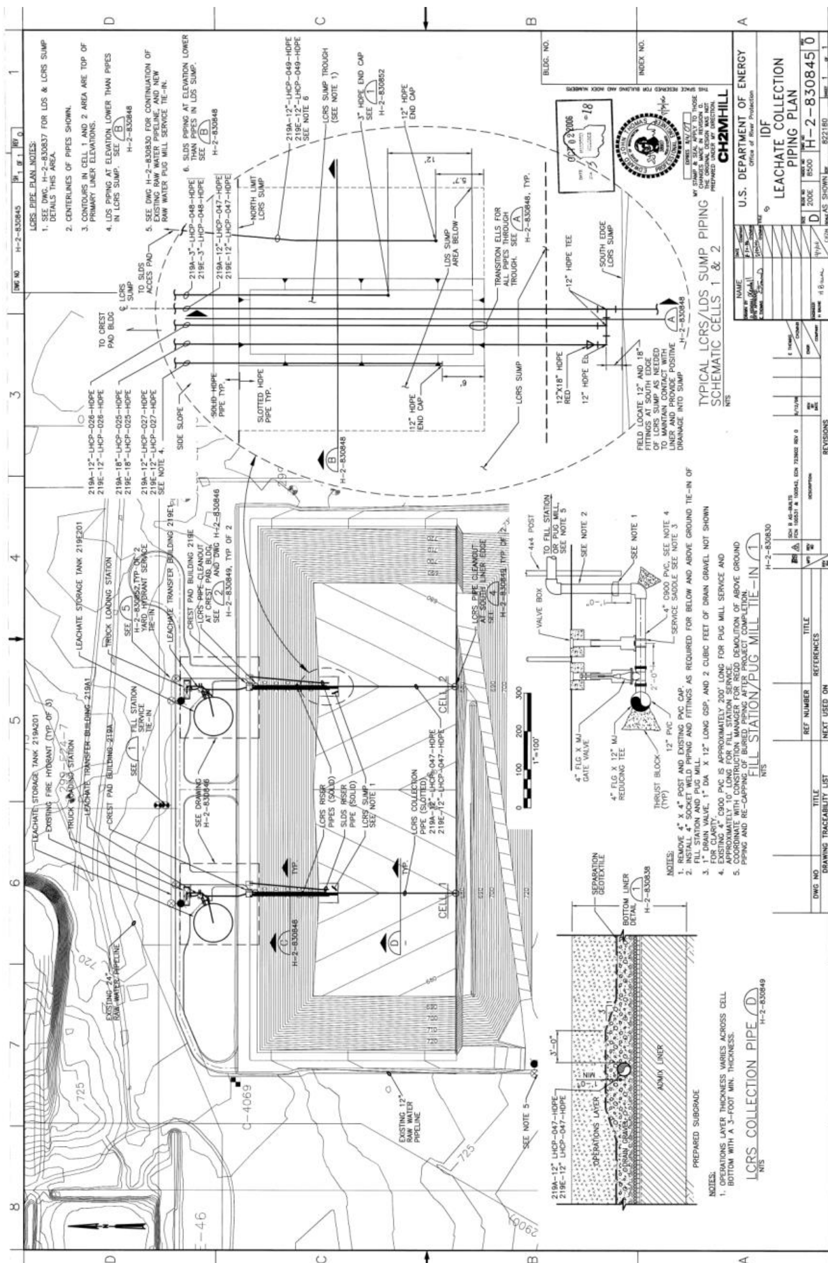

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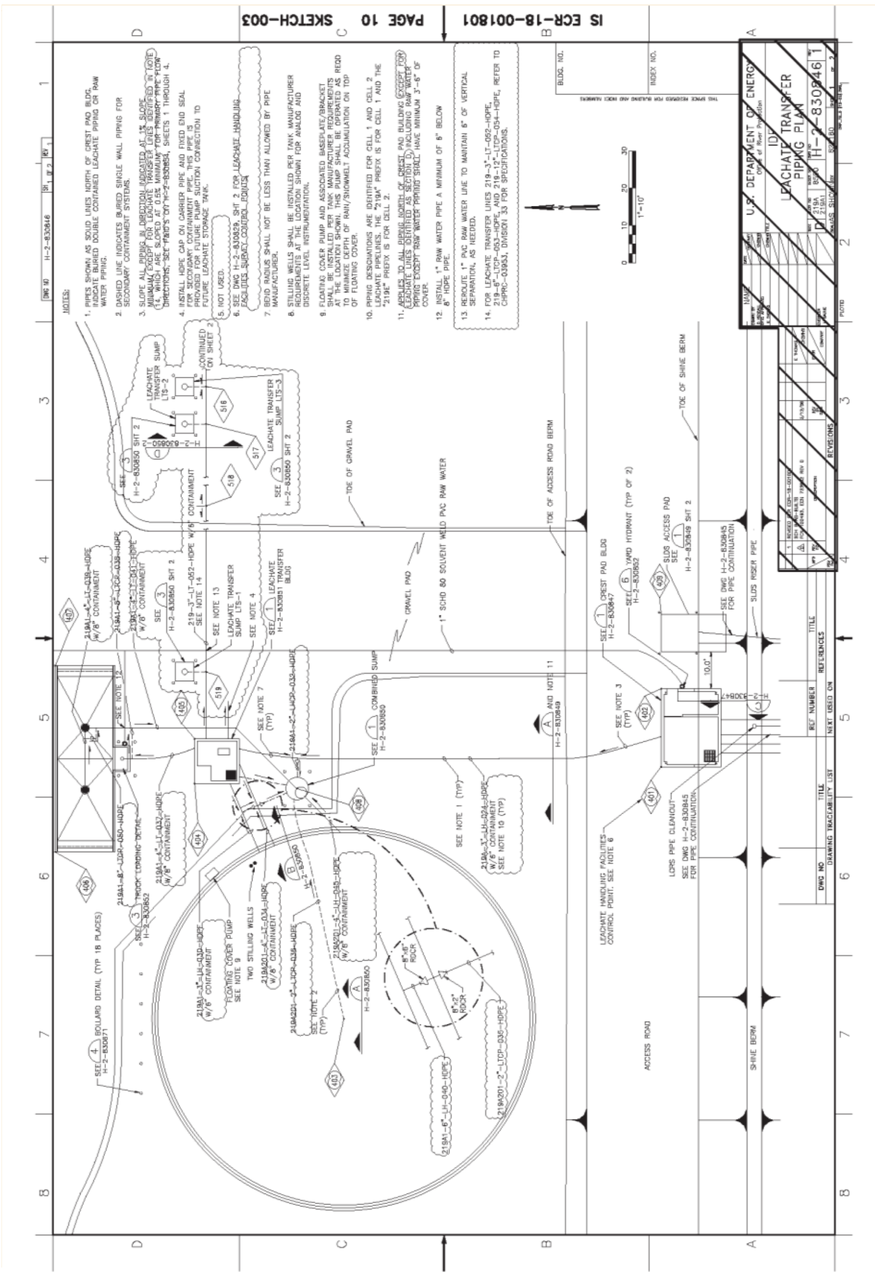

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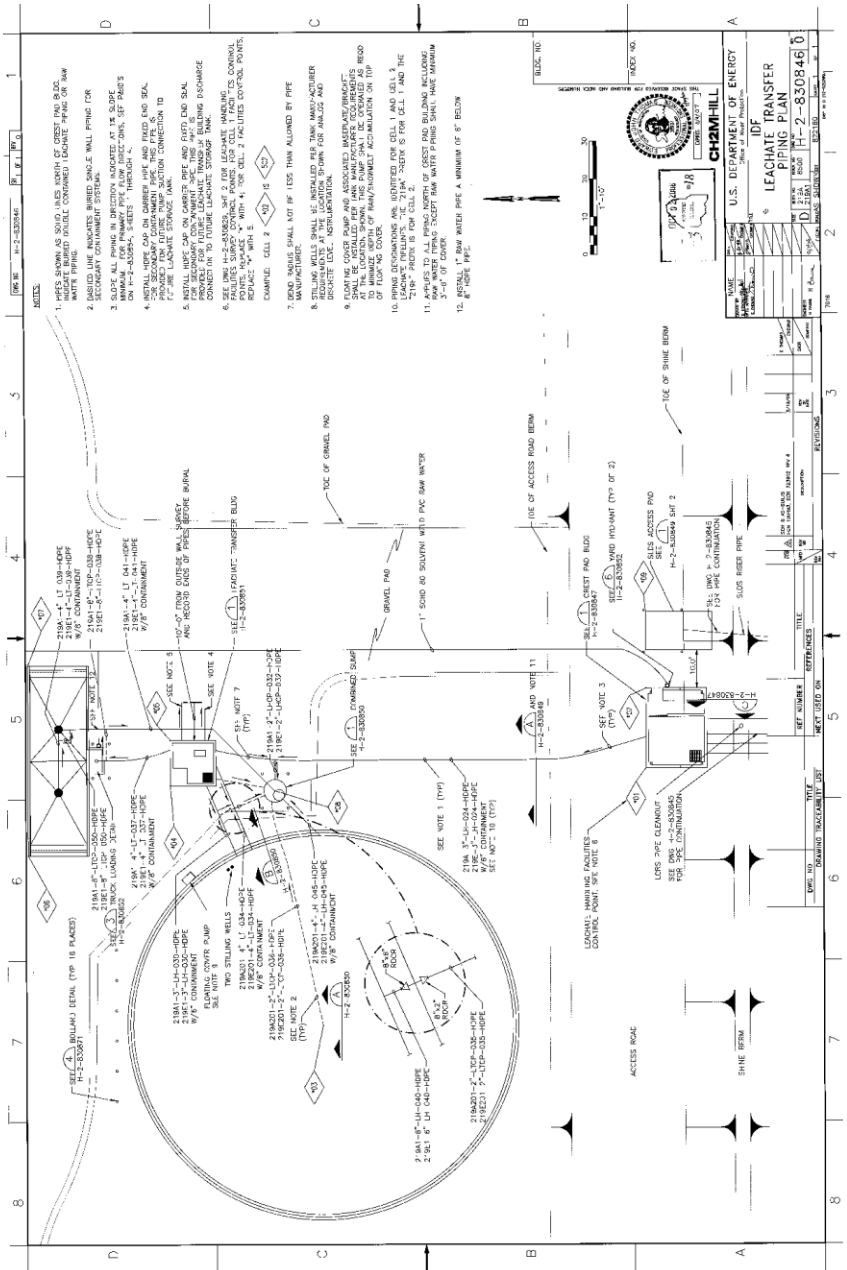

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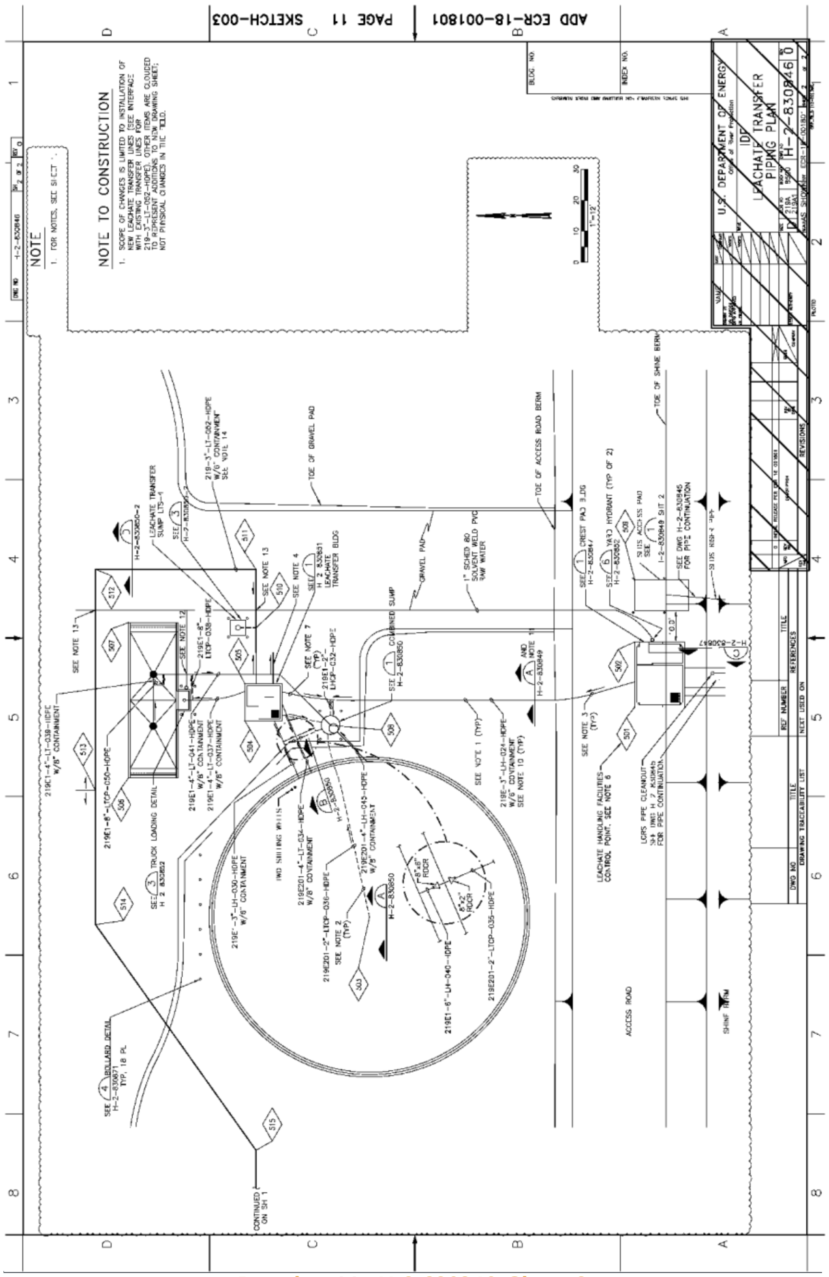

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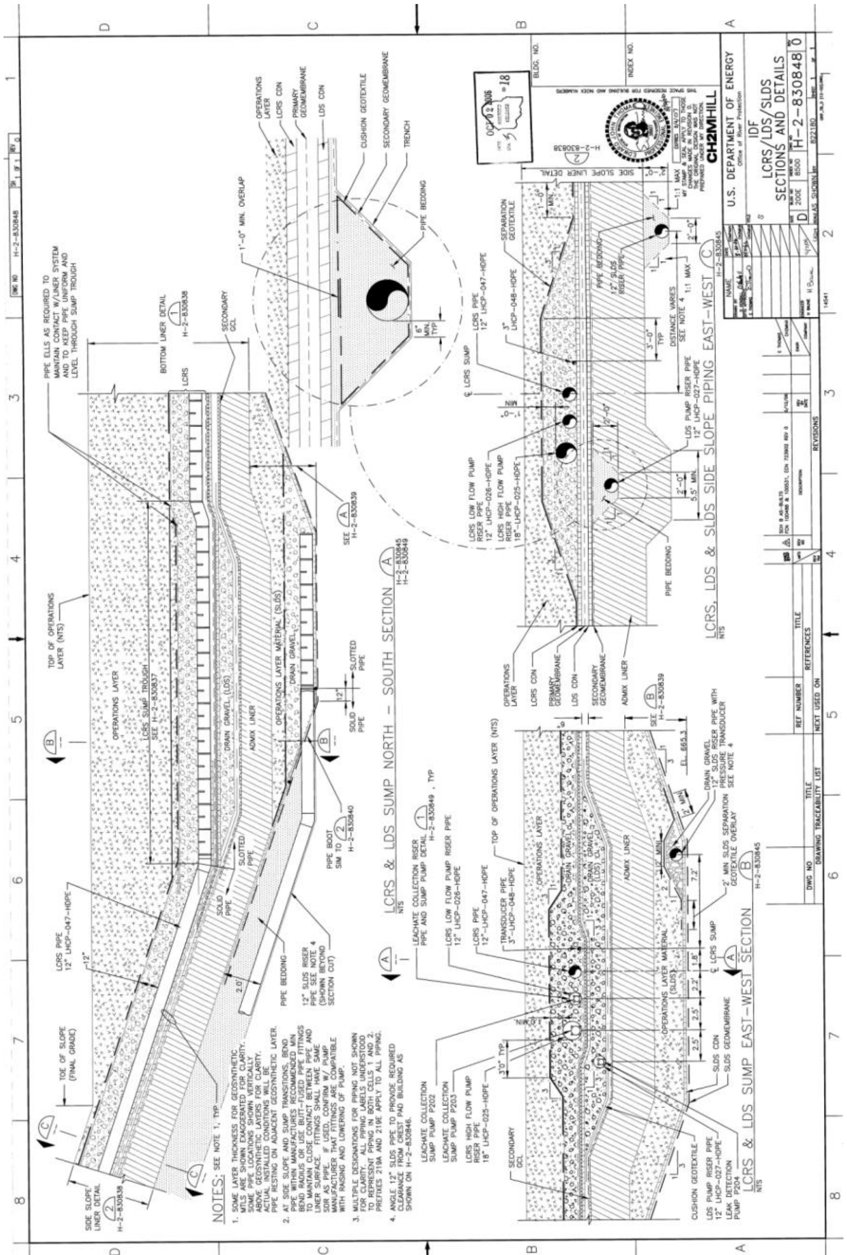

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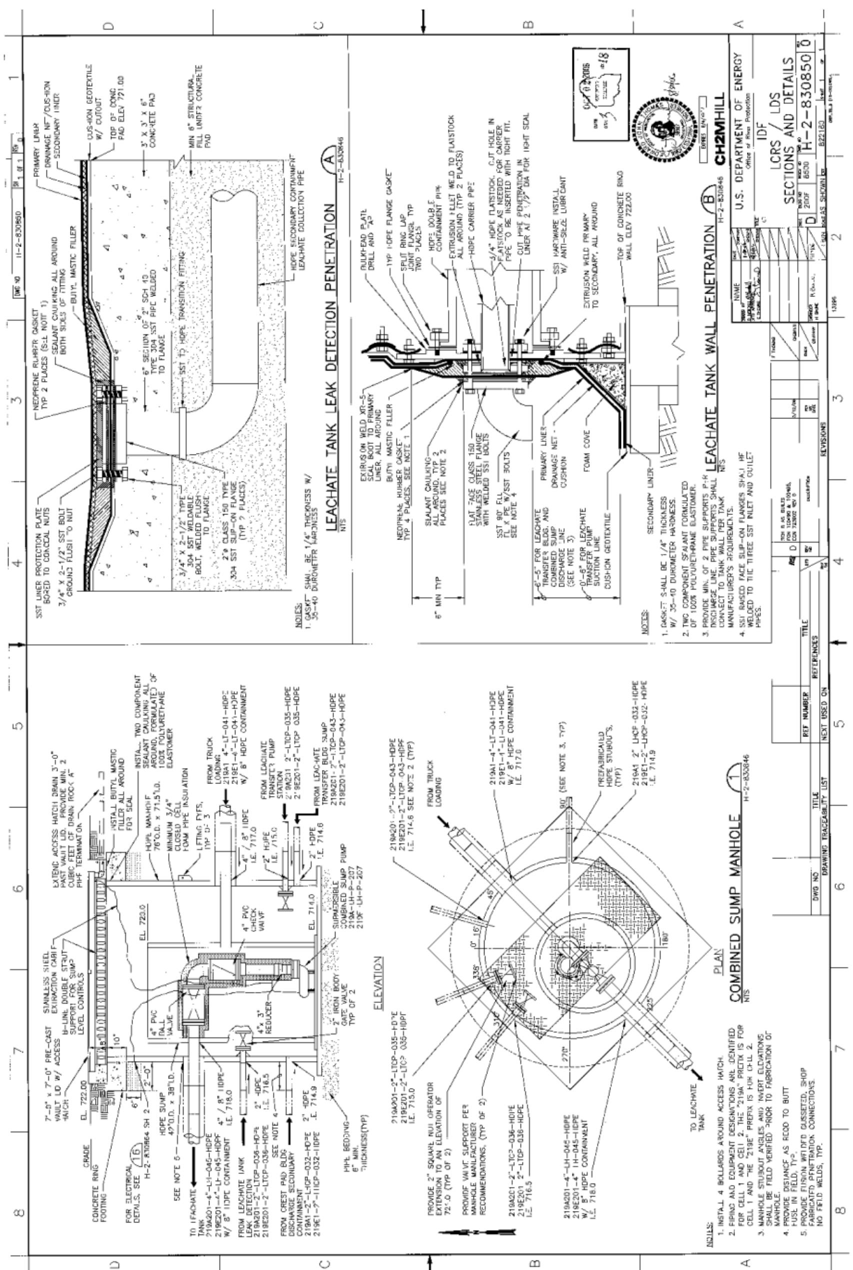

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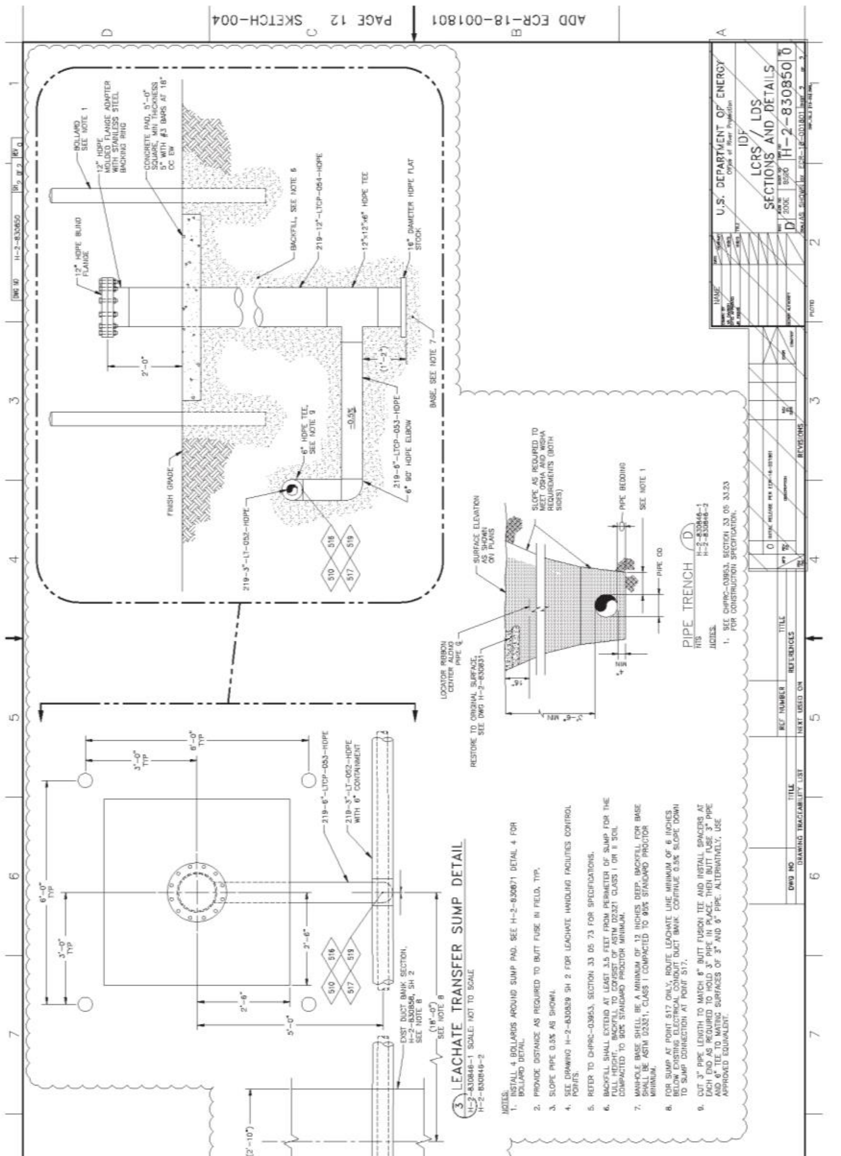

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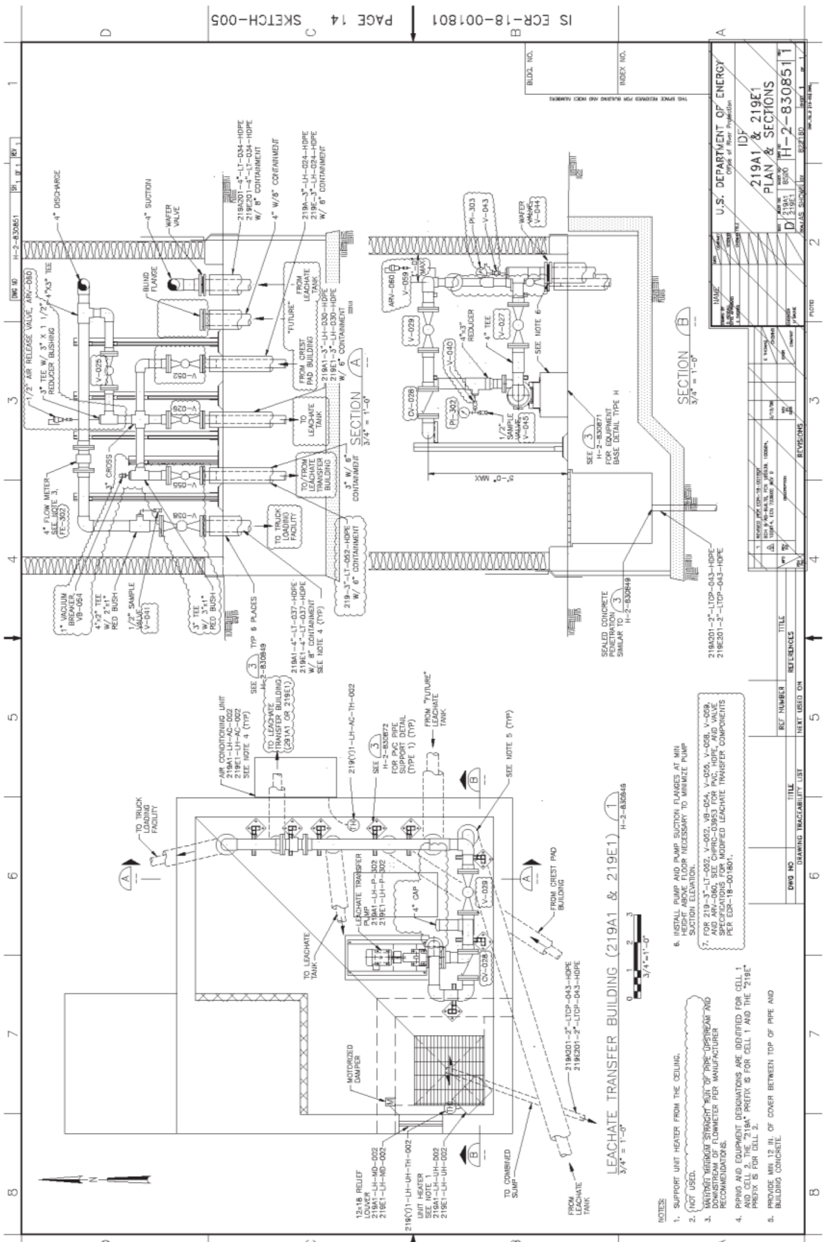

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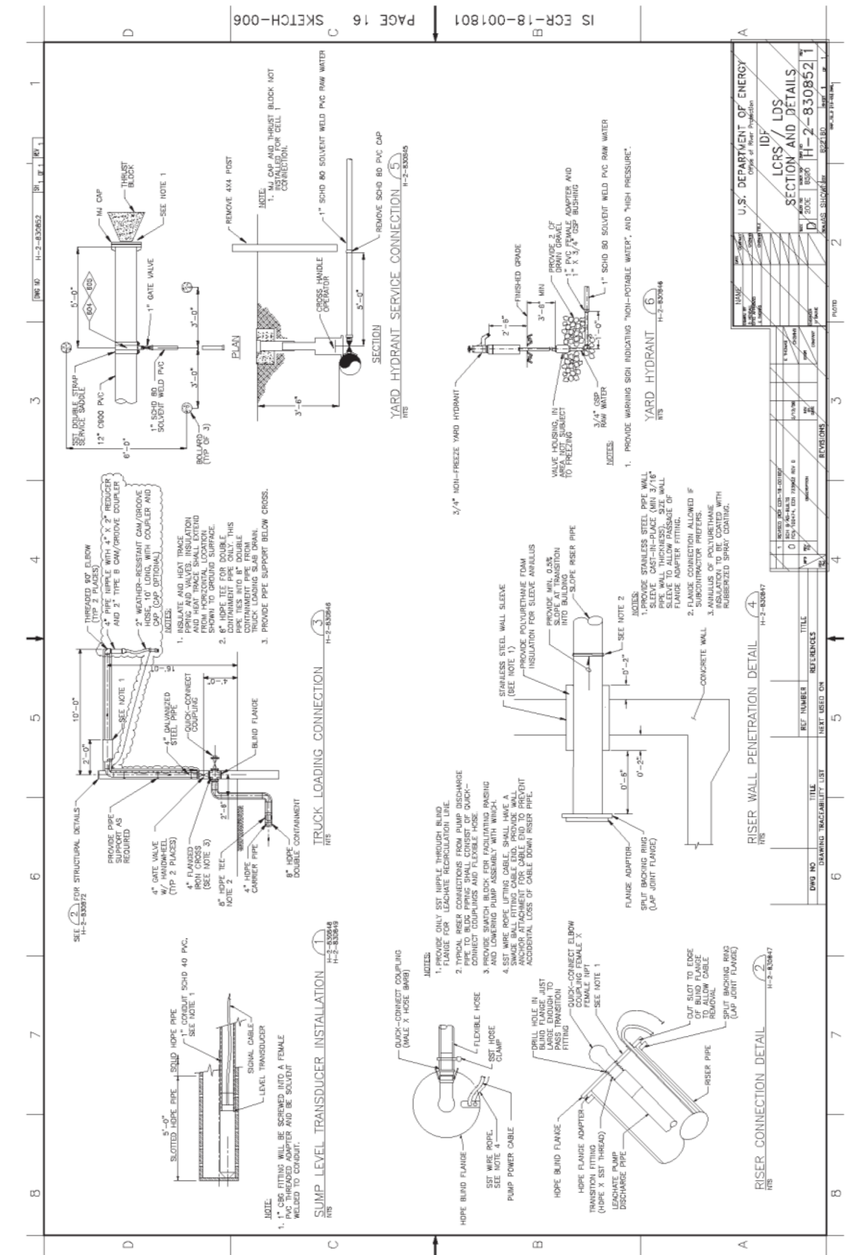

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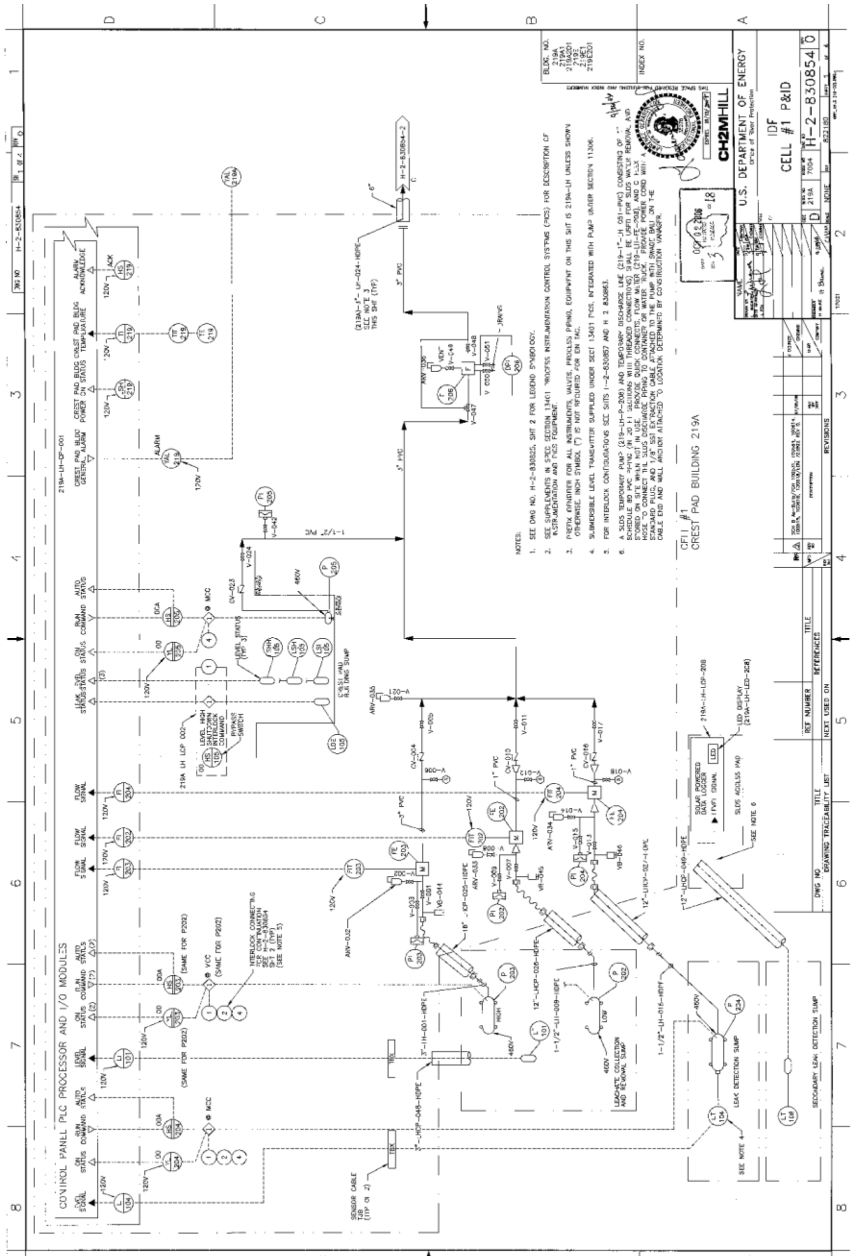

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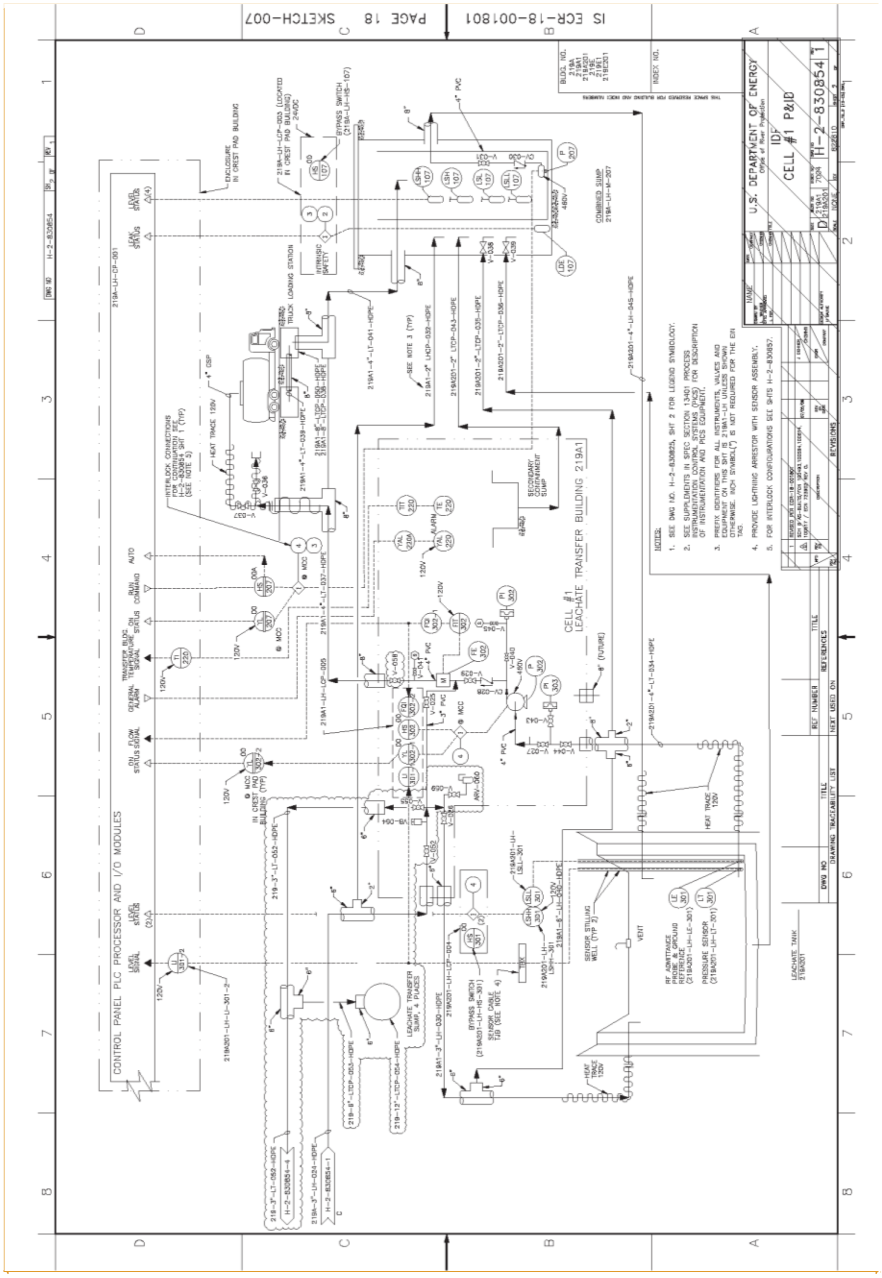

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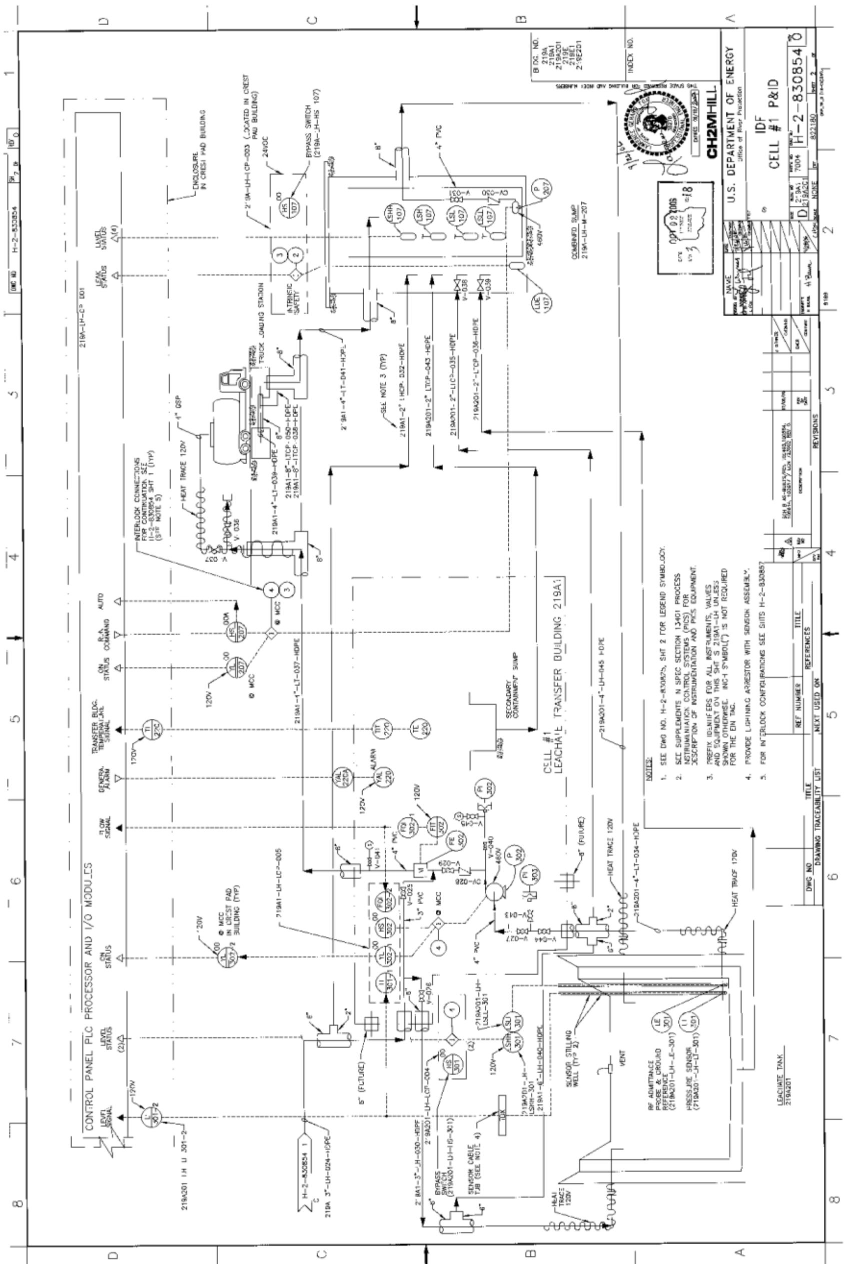

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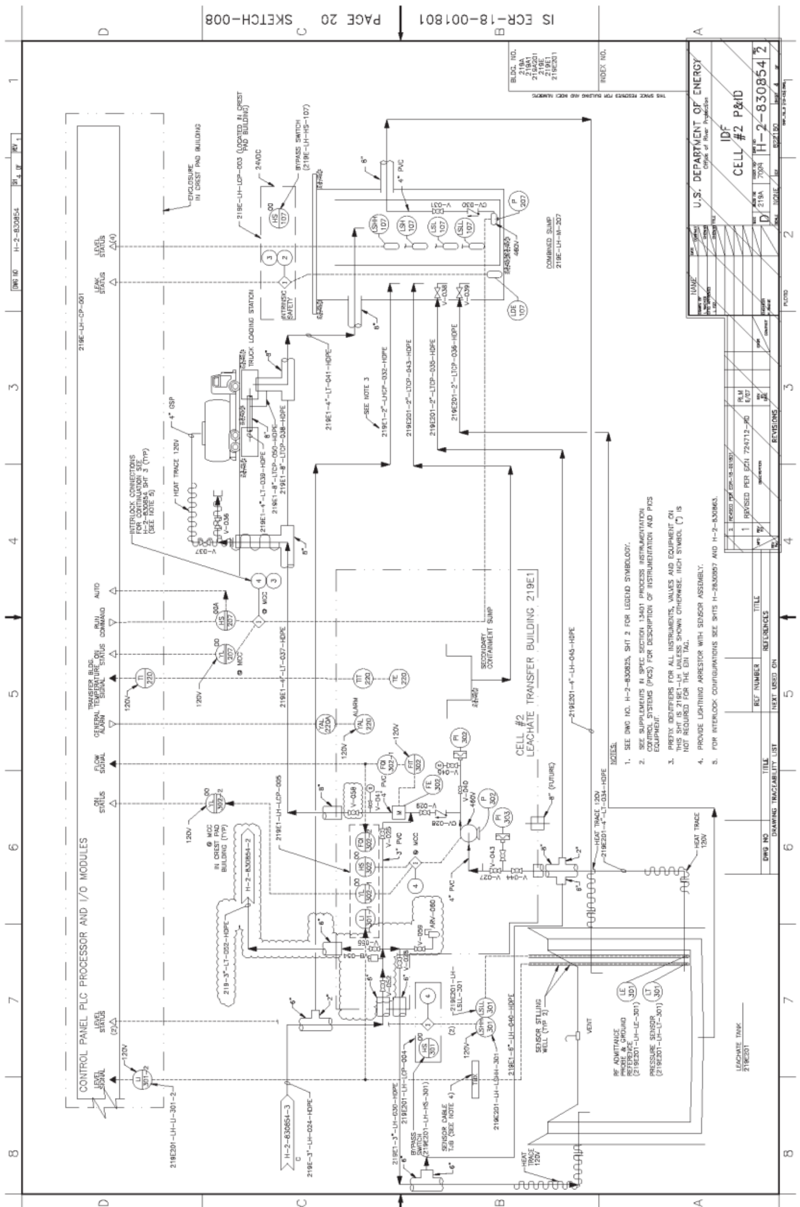

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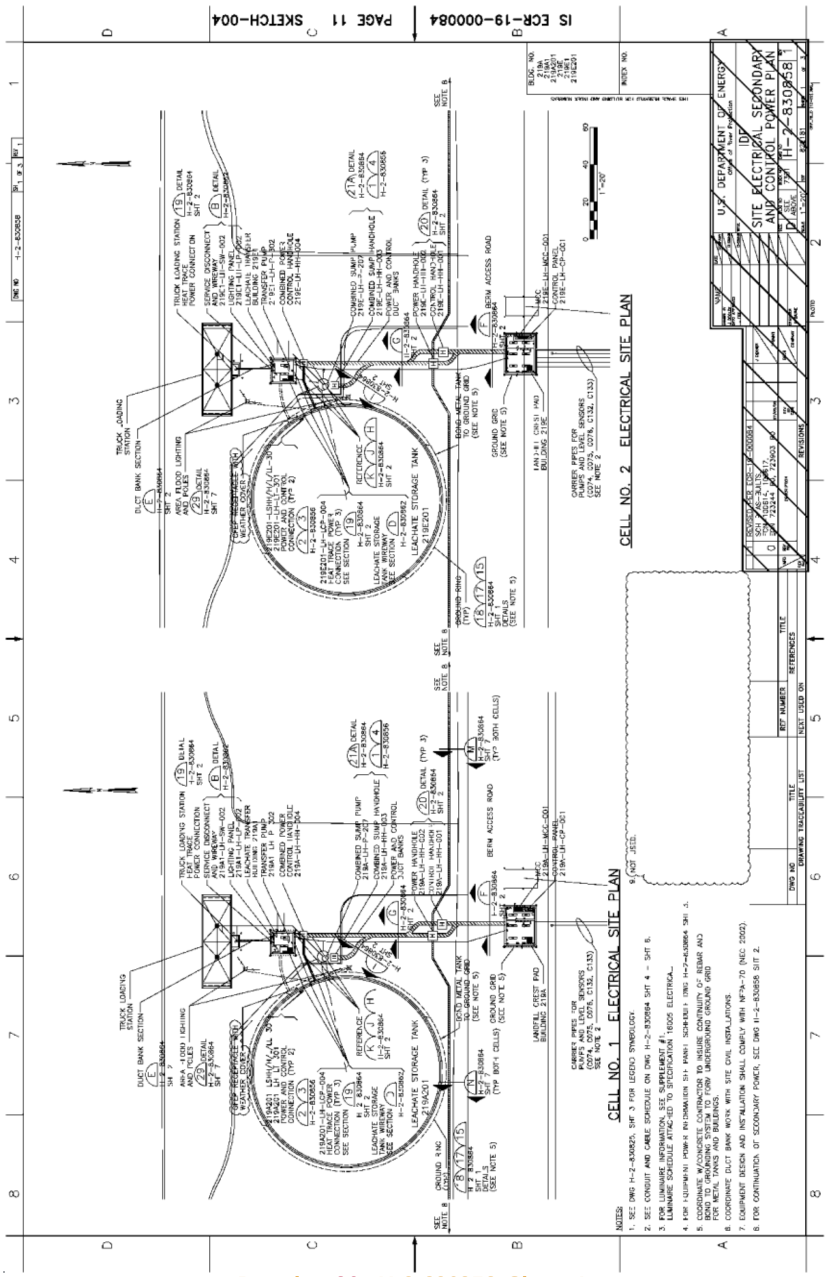

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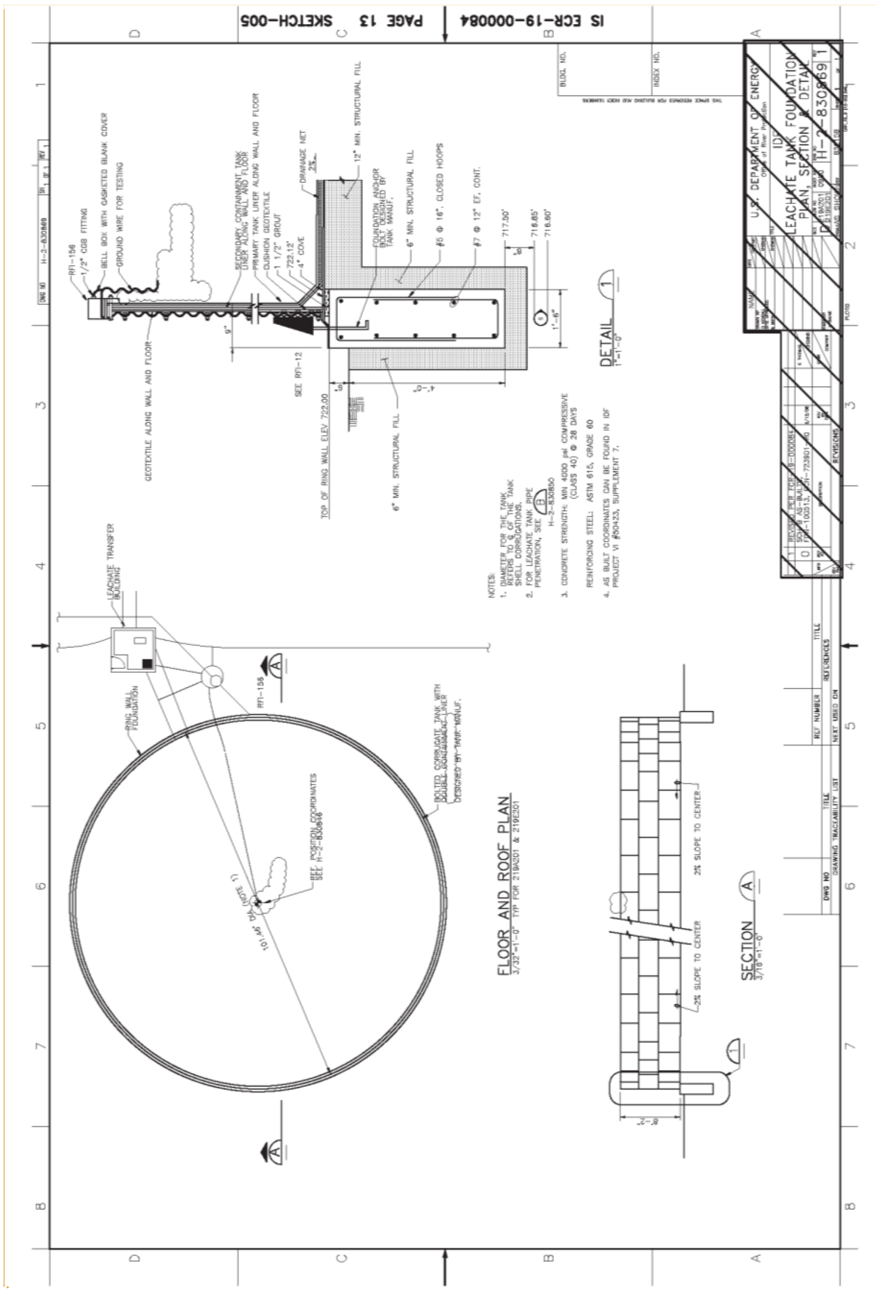

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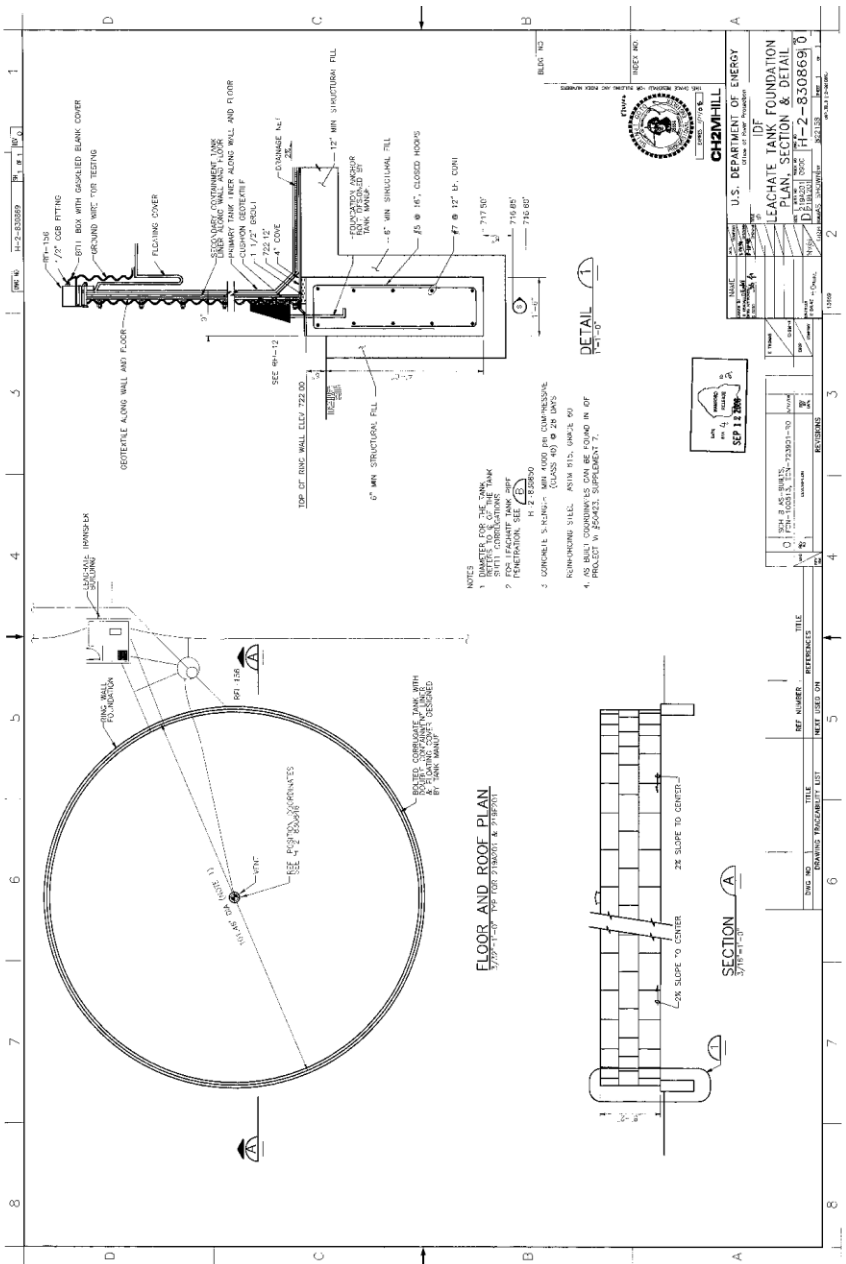

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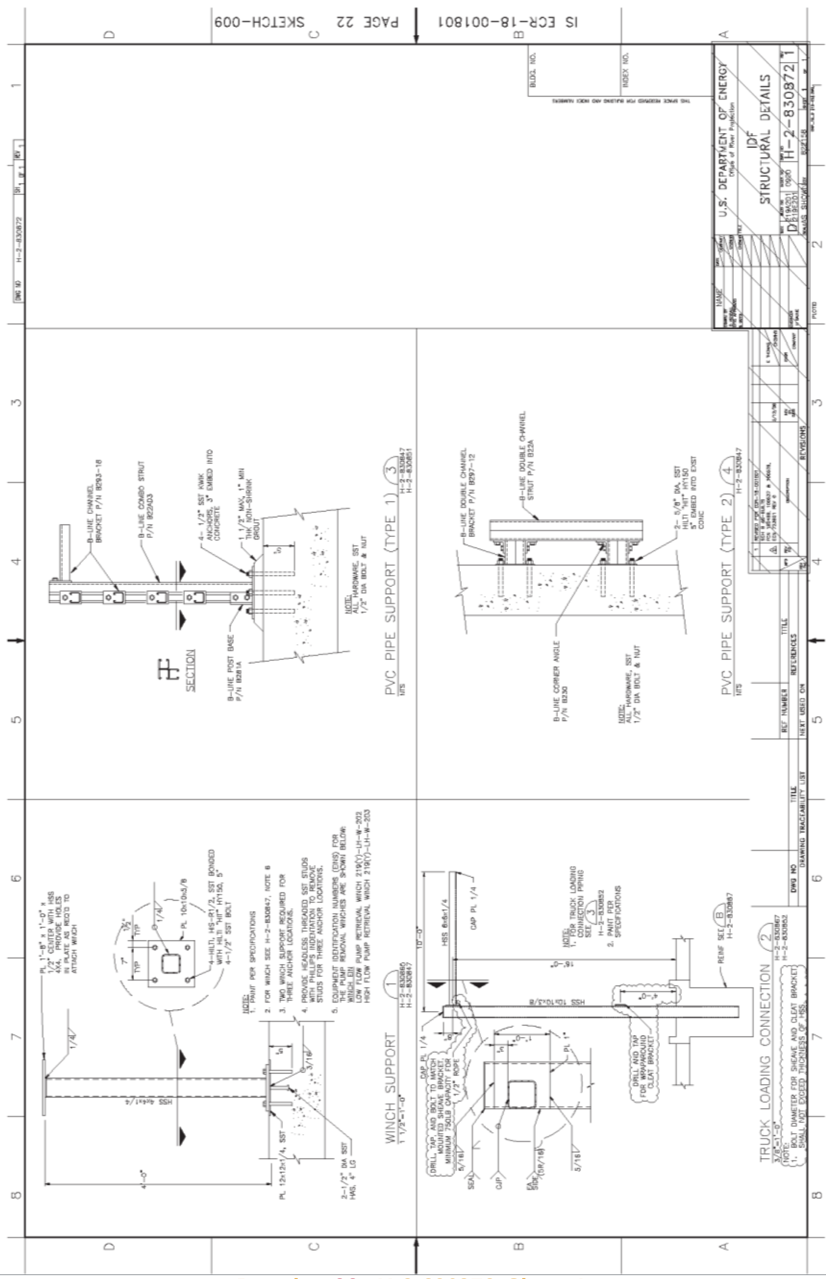

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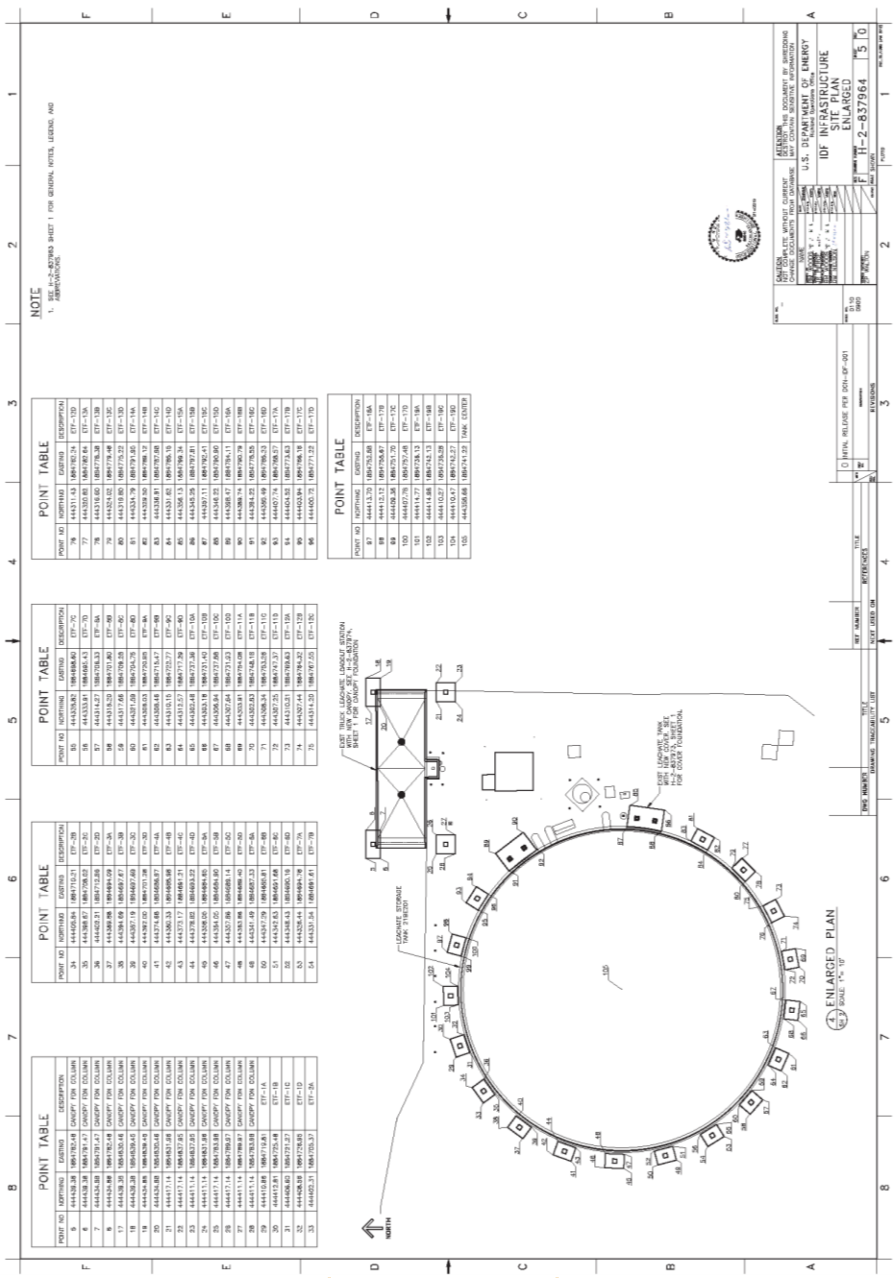

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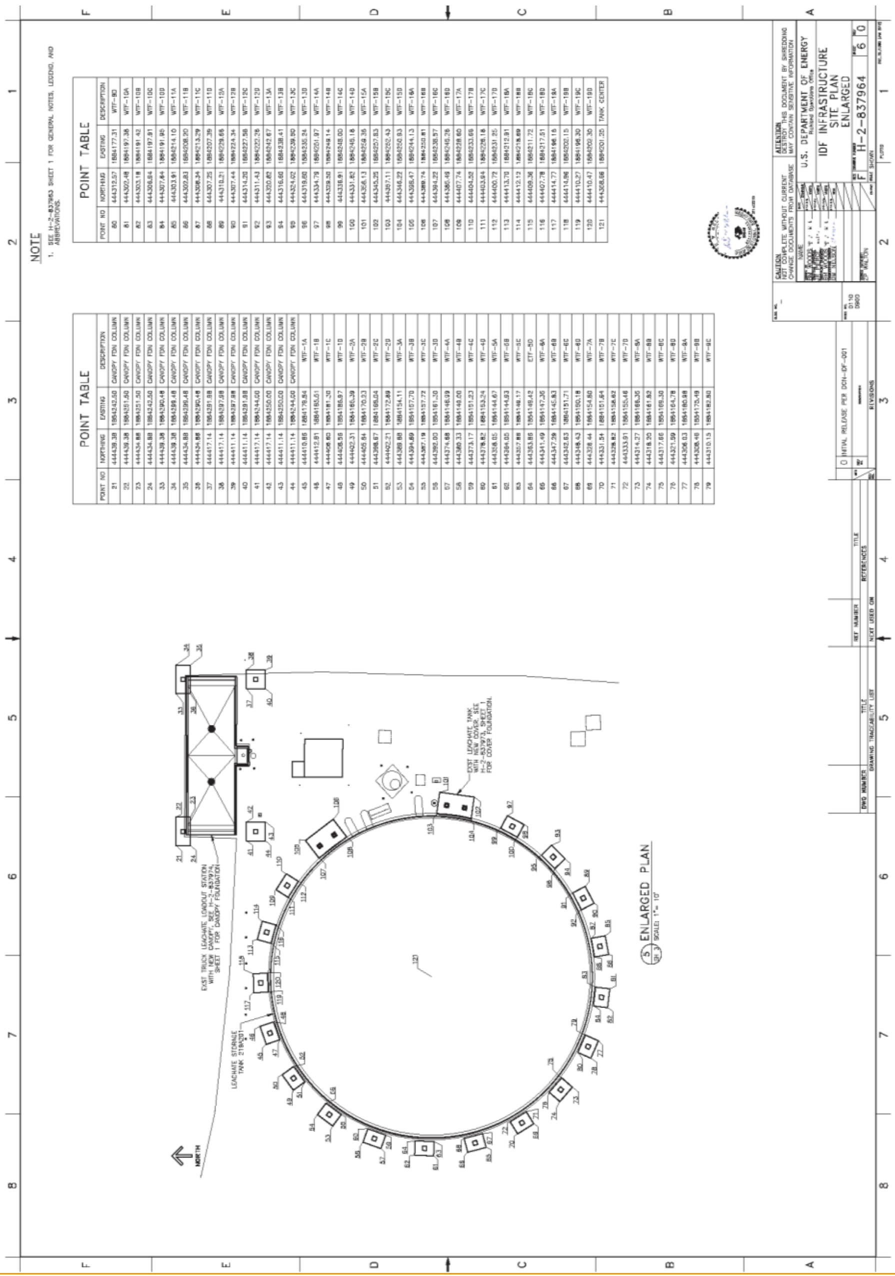

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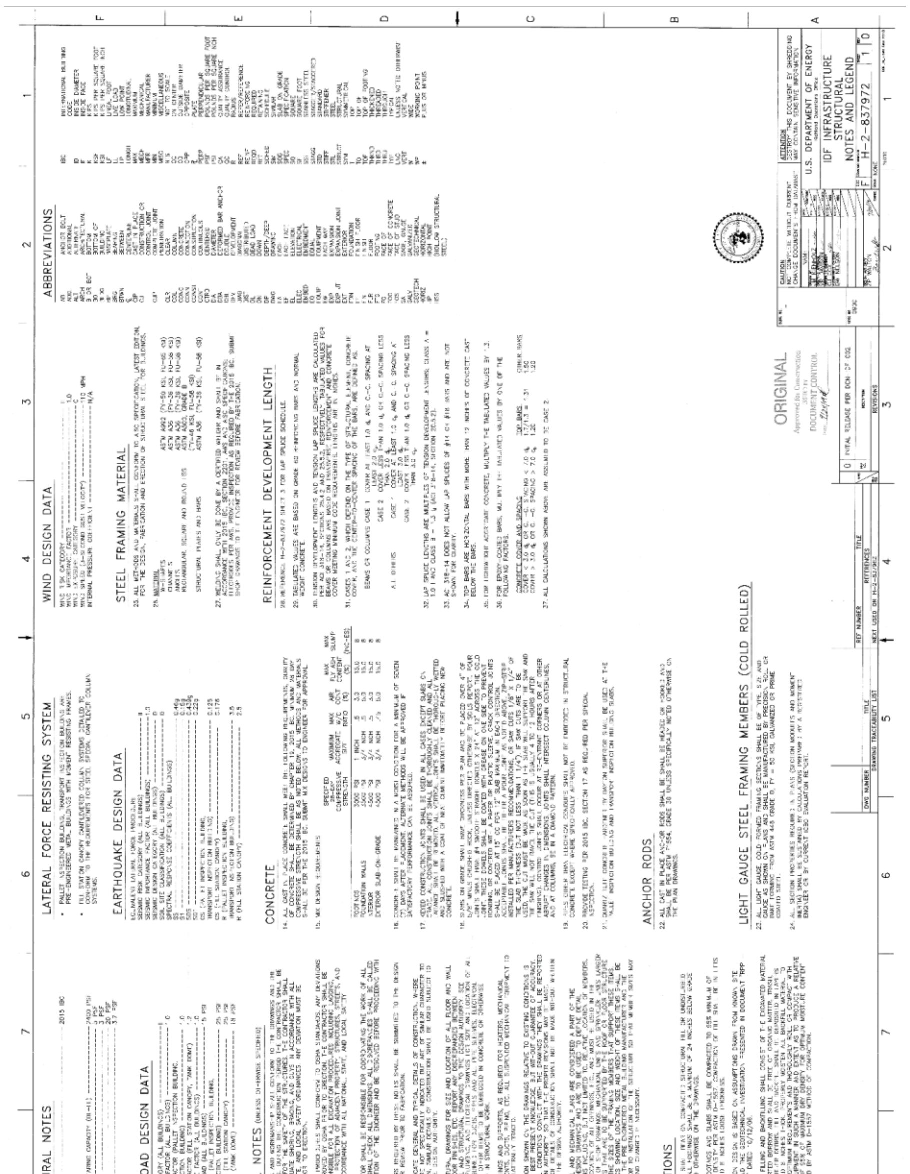

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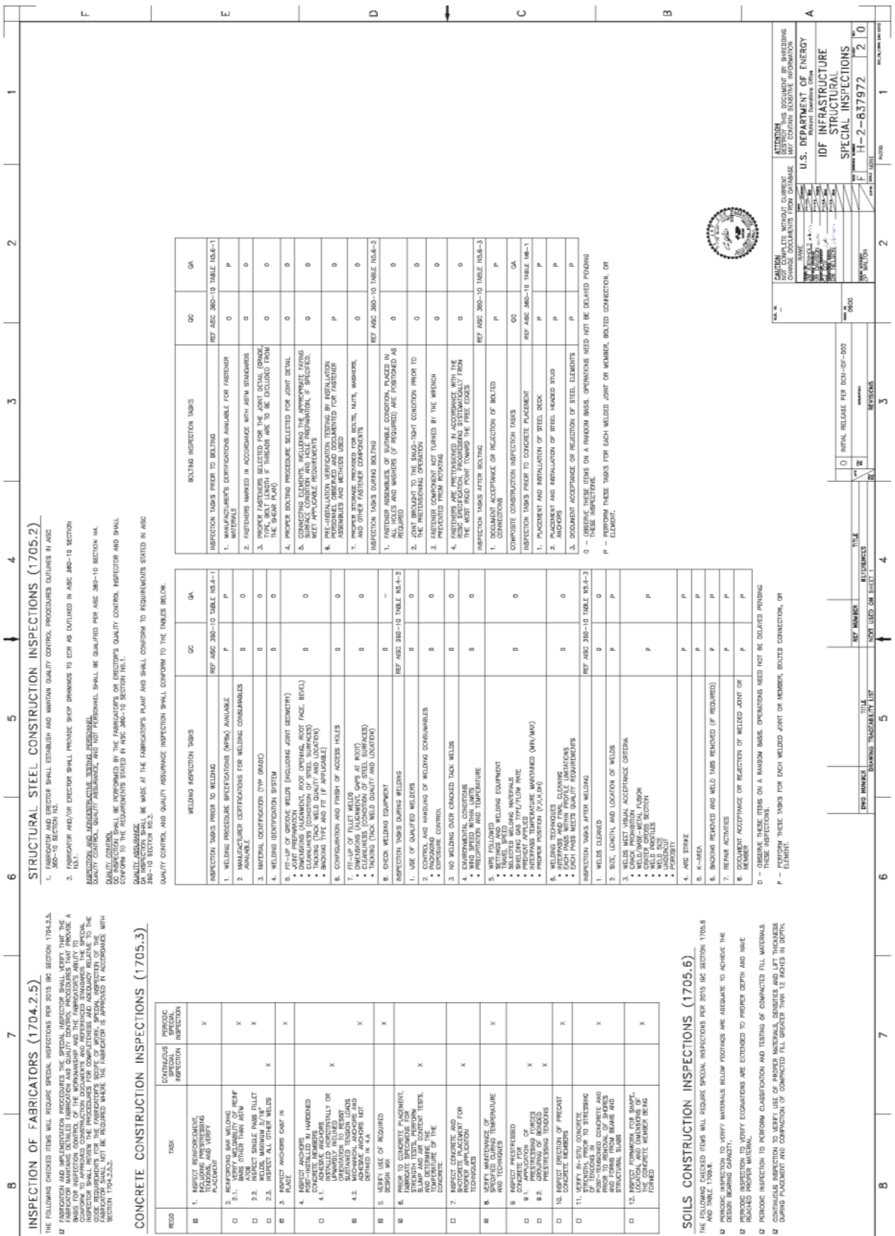

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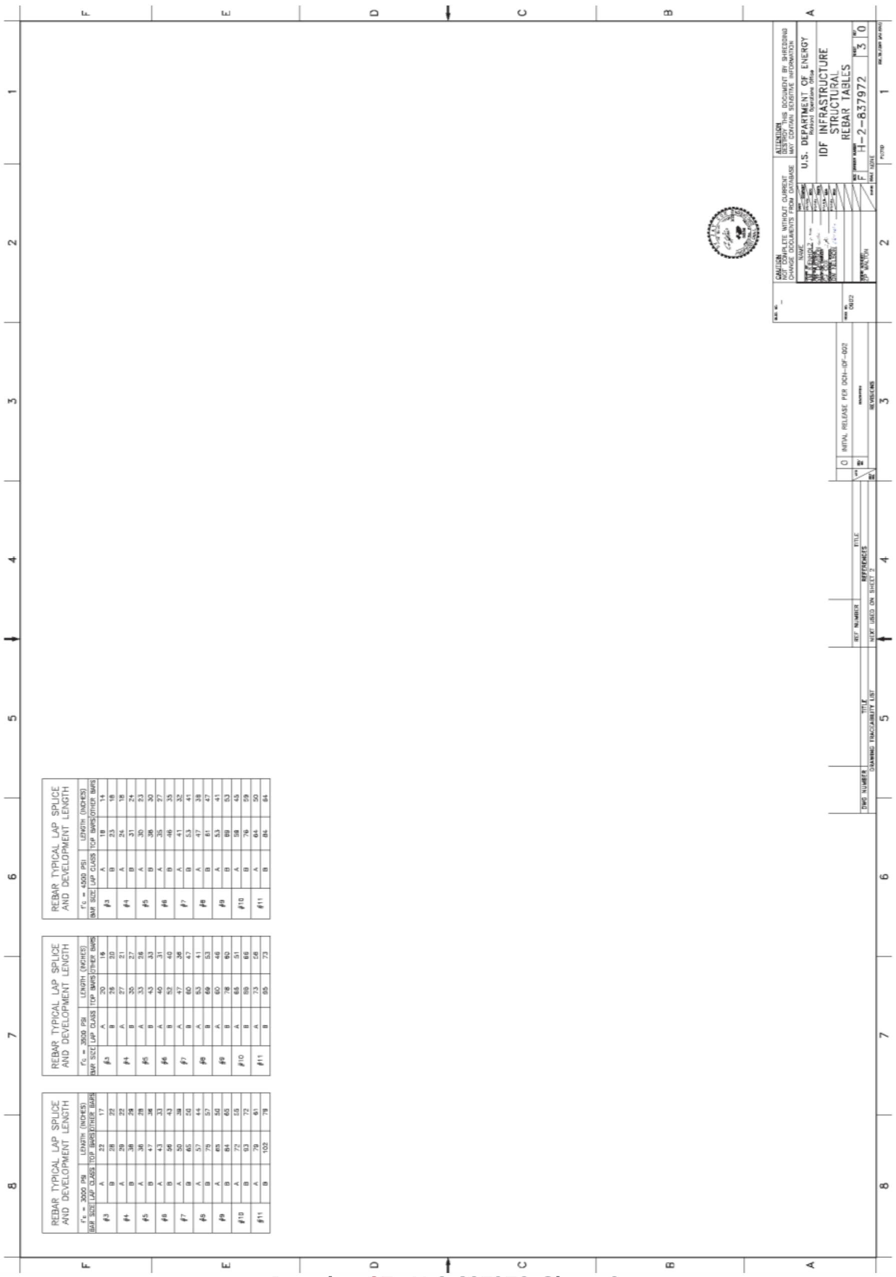

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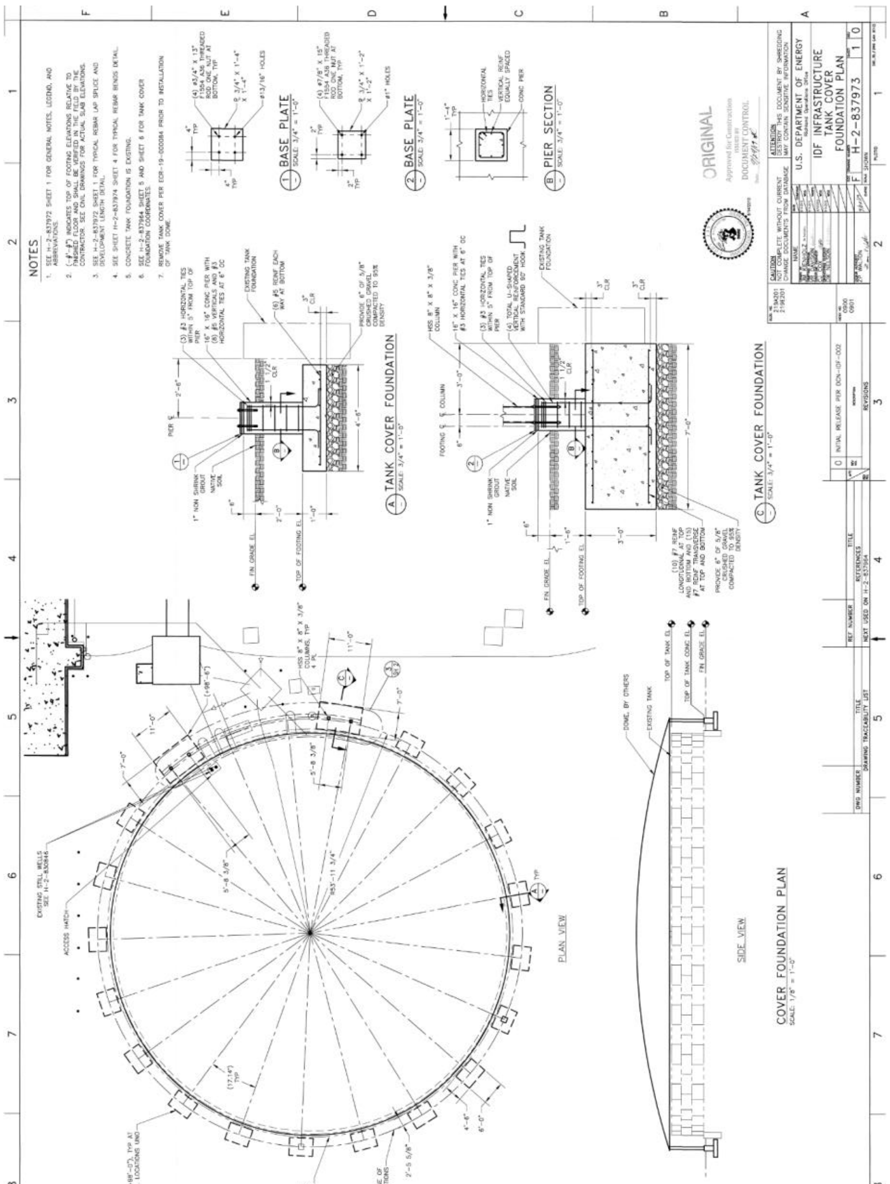

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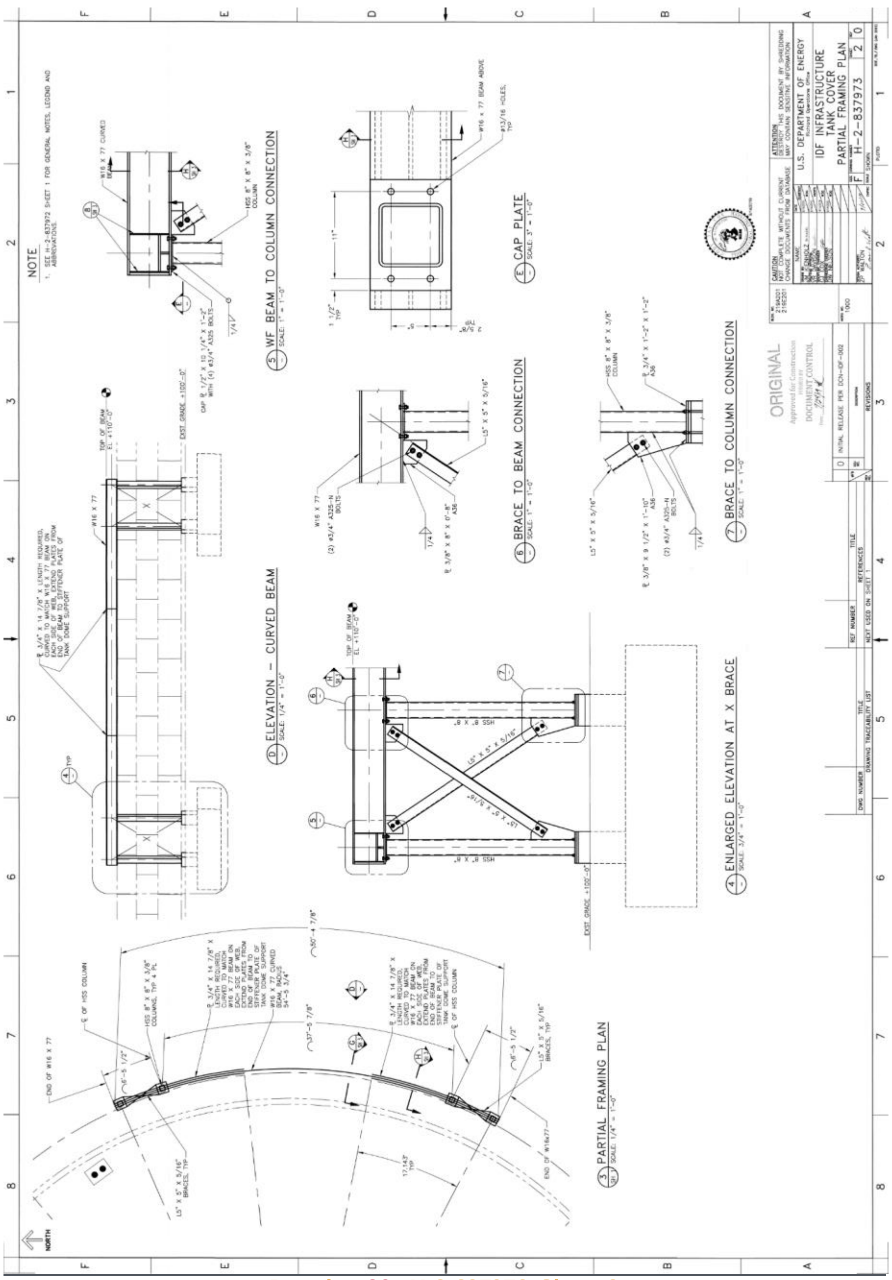

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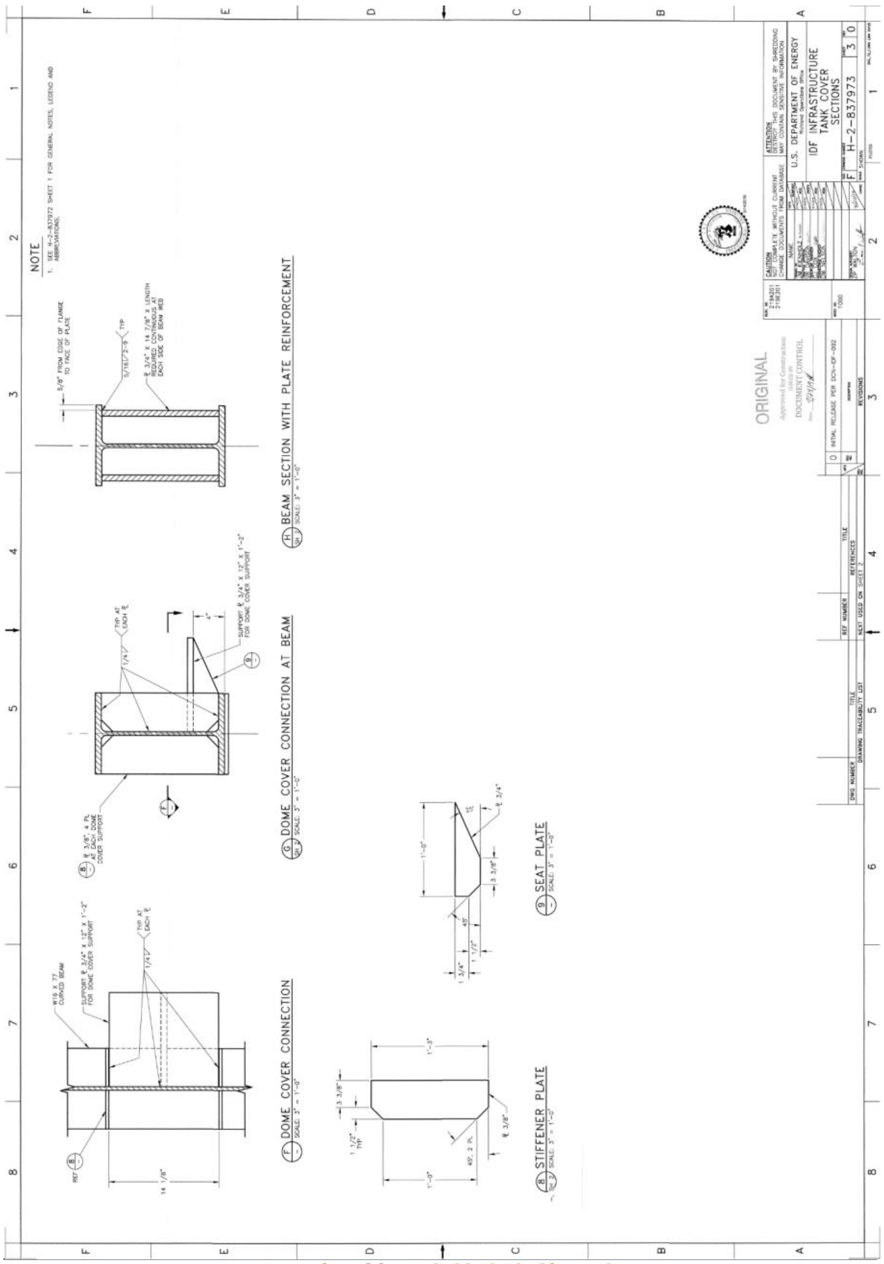

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INTEGRATED DISPOSAL FACILITY
APPENDIX 4D
CONSTRUCTION SPECIFICATIONS (C-1)
RPP-18489, REV. 1

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
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APPENDIX 4D
CONSTRUCTION SPECIFICATIONS (C-1)
RPP-18489, REV. 1

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APPENDIX 4D
CONSTRUCTION SPECIFICATIONS (C-1)
RPP-18489, REV. 1

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DIVISION 1–GENERAL REQUIREMENTS

DIVISION 2–SITE CONSTRUCTION

SECTION 02200 – SITE PREPARATION SCHED. A & B

Part 1 – General

Work Included

This section describes requirements for clearing, grubbing and stripping of the IDF project area and associated facilities.

Definitions

Interfering or Objectionable Material: Trash, rubbish, and junk.

Clearing: Removal of existing vegetation and interfering or objectionable material lying on or protruding above ground surface.

Grubbing: Removal of vegetation and other organic matter including sagebrush, stumps, buried logs, and roots greater than 2 inches caliper to a depth of 6 inches below subgrade.

Stripping: Removal of topsoil and other organic matter. Strippings suitable for topsoil shall be limited to upper 6 inches.

Project Limits: Areas actually needed for site improvements, stockpiles, and borrow areas, as shown or specified, within which work is to be performed.

Raw Water Supply

Depending on the availability of connections to the raw water pipeline system, water for dust control may be obtained either from an existing water fill station on 4th Street near the west exit of the 200 East Area or from the raw water line that crosses the IDF site. A new raw water pipeline is being installed as part of Schedule A of the IDF project.

Whether water is obtained from the existing water fill station or from new facilities on the IDF site, use of connections to the raw water system shall be in accordance with guidance from the Hanford Site Water Purveyor. Use and discharge of raw water during construction for construction activities, including dust control and fire protection, shall be controlled through the Hanford Site Water Purveyor, and shall comply with WAC 173-200 and the State Waste Discharge Permit No. ST 4508. For any use of existing water fill station or a water connection on the IDF site, the total of all IDF project water usage from the raw water system shall not exceed 1,500 gpm. There is no guarantee that the 1,500 gpm will be available at all times or that will be available from a single location on the IDF water system. In addition, the maximum water use limitation may be periodically reduced by the Hanford Site Water Purveyor depending on the other Hanford Site demands on the raw water system and/or the availability of raw water pumping capacity within the Hanford raw water system. When using any connection to the raw water system, the Construction General Contractor shall take whatever means are necessary to operate fill stations and other connections in such a manner to prevent causing water hammer. If water usage from the system is found to cause water hammer, the Hanford Site Water Purveyor may require the use of orifice plates, changes to valve operation methods, and/or a reduction in water use at a water connection as necessary to eliminate the water hammer. For any onsite fill station, Construction General Contractor shall provide a water storage tank (minimum size 20,000 gallons) equipped with a float actuated fill valve to minimize demand surges on the Hanford Water Supply.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Site Preparation Plan: Prior to any mobilization of equipment to the site, the Construction General Contractor shall submit a Site Preparation Plan for approval. This plan shall include the following information as a minimum:

Detailed description of the proposed method for clearing, grubbing, and stripping the site. The plan shall identify those areas of the project site, which will be cleared, grubbed, and stripped. In addition, it will identify staging areas, stockpile areas, and the sequence in which the site preparation will be executed.

Dust Control Plan:

Prior to any earthwork activities on the project site such as site preparation and excavation, Construction General Contractor shall submit a Dust Control Plan for approval. The plan shall identify methods and equipment to minimize/control dust generation during all earthwork operations and include the following minimum requirements:

Continuous control of dust generation during excavation and backfill placement, etc.

Continuous control of wind-generated dust, including disturbed areas that are not being actively worked.

Keep haul roads watered to control dust.

A minimum two full water trucks (5,000 gallons each) for the duration of the project.

Apply water or other approved dust suppressants as minimum to keep visible dust to a minimum during execution of work.

Appropriate hand-held hose lines, sprinklers, and other equipment as needed to access and control non-vehicle access areas such as borrow and stockpile side slopes.

Maintain and protect native cover where possible, through minimization of site disturbance.

Limit access road development to minimum necessary to execute work.

Stabilization of inactive disturbed work areas by longer-term methods such as matting, tack and mulch or crusting agents.

Implementation of permanent stabilization on a regular basis when sufficient area exists for application or as needed to control dust.

General Construction Contractor shall use daily field reports to document dust control measures implemented and their effectiveness.

These dust control plan items are required to satisfy the requirements of Section 3.0 - Mitigation of Potential Dust Impacts from Construction Activities of the "Mitigation Action Plan for USDOE, Hanford Site, Immobilized Low-Activity Waste (ILAW) Disposal Site Construction (Project W-520)," prepared by PNNL for USDOE.

Submit details of raw water supply, storage, and water withdrawal limiting equipment as part of the Dust Control Plan.

Scheduling and Sequencing

The sequence of the activities listed below shall be followed by the Construction General Contractor for the site preparation work.

Initial site preparation activities shall commence only after Dust Control Plan and Site Preparation Plan have been approved.

Following the approved Site Preparation Plan, establish an adequate water supply source for dust control use.

After establishing an adequate water supply and sediment controls, proceed with site preparation activities as specified.

Part 2 – Products (Not Used)

Part 3 – Execution

General

Clear, grub, and strip only areas actually needed for stockpiles, borrow, or site improvements within limits shown and specified.

Extent of Site Preparation required for individual designated stockpile areas shall be as directed by the Construction Manager.

Do not injure or deface vegetation that does not require removal.

As an initial step in clearing the site, the General Construction Contractor shall remove all trash, rubbish, and junk from the site. This material shall be disposed in accordance with Division 1 requirements.

Clearing

Cut off shrubs, brush, weeds, and grasses to within 4 inches of ground surface.

Grubbing

Grub all areas where excavations, fill, roadways, structures, and ditches are to be placed.

Vegetation other than noxious weeds, removed by the clearing and grubbing, shall be placed in stockpile with the strippings to be used as topsoil. Place vegetation at the base of the strippings stockpile area and track with equipment to break apart and crush the material. Obtain Construction Manager approval of the vegetation placement.

Stripping

Strip all areas where excavations, borrow areas, stockpiles, fills, roadways, structures, and ditches are to be placed, to remove organic materials. Do not remove subsoil with topsoil.

Stockpile strippings from the upper 6 inches below ground surface after clearing and grubbing, meeting requirements for topsoil in Section 02920, RECLAMATION AND REVEGETATION, separately from other excavated material at either the designated stockpile area location shown on the Drawings, or other areas as approved by the Construction Manager.

IDF Raw Water Connections

General Construction Contractor shall take necessary steps to prevent freezing and/or damage to the IDF raw water system connections.

Disposal

Clearing and Grubbing Debris: Bury vegetation that is not suitable for topsoil at a designated area as directed by the Construction Manager. Disposal of the remaining interfering or objectionable material shall be in accordance with Division 1 requirements.

Strippings: Dispose of strippings that are unsuitable for topsoil as specified above for clearing and grubbing debris.

Burning Prohibited: No burning of any materials generated during the site preparation work will be allowed at the site.

END OF SECTION 02200

SECTION 02315 – FILL AND BACKFILL SCHED. A & B

Part 1 – General

Work Included

This section describes placement and testing of fill and backfill in general areas of the site (including stockpiles).

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

Definitions

Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.

Apply corrections for oversize material to maximum dry density.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

Completed Course: A course or layer that is ready for next layer or next phase of Work.

Lift: Loose (uncompacted) layer of material.

Geosynthetics: Geotextiles, geocomposites, geosynthetic clay liner, or geomembranes.

Well-Graded:

A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.

Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1-foot outside outermost edge at base of foundations or slabs.

1-foot outside outermost edge at surface of roadways or shoulder.

0.5-foot outside exterior at spring line of pipes or culverts.

Imported Material: Materials obtained from sources offsite, suitable for specified use.

Standard Specifications: When referenced in this section, shall mean Standard Specifications for Road, Bridge, and Municipal Construction, as published by the Washington State Department of Transportation, 2002 edition, English units.

SLDS: Secondary Leak Detection System.

Permanent Stockpile: Stockpile of material that remains at the completion of construction.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials from independent testing laboratory as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

Stockpile Plan: Prior to any excavation activities associated with construction of the IDF, Construction General Contractor shall submit a Stockpile Plan for approval. The plan shall include the following information:

Scale drawing, using the project plans as a base, which shows the proposed location for stockpiles on the project site. Show all access roads around stockpiles. Address stockpile locations during construction of the IDF and permanent stockpiles, which will remain upon completion of construction activities for this project.

Stockpile layout drawings, which show the estimated location of toe of slope and top of slope for each stockpile. Drawings shall show plan and typical sections and shall be fully dimensioned.

Plan shall show how differing materials encountered during the excavation will be segregated for future use. This includes material for use as topsoil, admix base soil, and operations layer. Also, show a stockpile area for material to be used in the future as clean backfill during landfill operations by the Tank Farm Contractor.

Method by which stockpile compaction will be achieved.

Dust control for the stockpiles during active use and until grass is established.

Placing of topsoil, seeding, fertilizing, and mulching each stockpile after active use of stockpile is finished in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Submittals–Approval Not Required

Information/Record (IR):

Qualifications of independent testing laboratory.

Qualifications of construction quality control personnel.

Construction quality control test reports

Sequencing And Scheduling

Complete applicable Work specified in Sections 02316, EXCAVATION, and 02319, SUBGRADE PREPARATION, prior to placing fill or backfill.

Permit Requirements

A backfill and fill permit is required for each backfill and fill work element. Construction General Contractor shall obtain from Tank Farm Contractor and post before starting backfill and fill work, as specified in Division 1, General Requirements.

Construction Quality Assurance (CQA)

The Construction General Contractor shall accommodate all CQA activities described herein and in the CPA Plan for this project. The CQA Plan is made part of these Specifications by reference.

The CQA Certifying Engineer shall determine in-place density and moisture content by any one or combination of the following methods: ASTM D2922, ASTM D3017, ASTM D1556, ASTM D2216, or other methods approved by the Construction Manager.

Testing requirements and locations will be determined by the CQA Certifying Engineer. Construction General Contractor shall cooperate with the CQA Certifying Engineer and testing work by leveling small test areas designated by the CQA Certifying Engineer. Backfill test areas at Construction General Contractor's sole expense. The CQA Certifying Engineer may have any material tested at any time, location, or elevation.

After Construction General Contractor makes repairs to any areas failing a test, the Construction General Contractor shall rerun appropriate tests, subject to the approval of the CQA Certifying Engineer, to demonstrate the area meets specifications, at the Construction General Contractor's sole expense.

The following minimum test schedule shall be assumed. Additional tests may be required as directed by CQA Certifying Engineer.

In-place density tests shall be made on the following minimum schedule:

Earth fill: One per 5,000 square feet (ft^2) per lift.

Structural Fill: One per 2,500 ft^2 per lift.

Subgrade Preparation: Four per acre.

Operations Layer (Outside Edge of Liner): One per 5,000 ft^2 per lift.

Operations Layer Material (SLDS): Two (2) per lift.

Standard Proctor (ASTM D698) laboratory density curves (five-point minimum) shall be performed for each material by the CQA Certifying Engineer. Samples of native materials used for embankment and backfill and samples of imported materials shall be taken at locations as specified by CQA Certifying Engineer.

Gradation tests (sieve analysis) shall be performed in accordance with ASTM D422 on operations layer material obtained from required excavations to demonstrate the materials meet the Specifications. Samples of operations layer material shall be taken from each 10,000 cubic yards of placed material in accordance with ASTM D75.

Part 2 – Products

Earthfill

Excavated material from required excavations and designated borrow sites, free from rocks larger than 4 inches in the greatest dimension, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

Structural Fill

Structural fill adjacent to concrete structures shall be as specified in Section 02320, TRENCH BACKFILL, for Pipe Bedding. Structural fill beneath concrete structures and beneath leachate storage tank shall conform to the requirements of Section 9-03 9(3) Crushed Surfacing-Top Course in the Standard Specifications.

Operations Layer

Meeting the requirements of earthfill above and having a maximum of 25 percent by weight passing the No. 200 U.S. sieve and a maximum particle size of 2 inches.

Drain Gravel

Material for drain gravel shall conform to the requirements of Section 9-03.12(4) of the Standard Specifications except material shall be subrounded to rounded gravel. Crushed rock and angular gravel shall not be allowed.

Crushed Surfacing

Material for crushed surfacing-base course and top course shall conform to the requirements in Section 9-03 9(3) of the Standard Specifications.

Quarry Spalls

Quarry spalls shall consist of broken stone free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather and shall meet the following requirements for grading:

Maximum Size: 8 inches

50 percent by weight shall be larger than 3 inches

Minimum Size: 3/4 inch

Source Quality Control

Gradation tests performed in accordance with ASTM D422 by a qualified independent testing laboratory shall be made for imported materials on samples taken at place of production prior to shipment. Imported materials shall not be shipped without submittal approval. Samples of the finished product for gradation testing shall be taken from each 2,000 tons of prepared materials in accordance with ASTM D75. Test results shall be submitted to Construction Manager within 48 hours after sampling. Size distribution for imported quarry spalls material shall be determined in accordance with one of the methods described in ASTM D5519.

Base Soil: As specified in Section 02666, ADMIX LINER.

Water For Moisture Conditioning: See Section 02200, SITE PREPARATION, for raw water supply availability and requirements for proper compaction.

Part 3 – Execution

General

Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

Place and spread fill and backfill materials in horizontal lifts of uniform thickness as specified in paragraphs BACKFILL UNDER AND AROUND STRUCTURES and FILL, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

Tolerances:

Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.

Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

Backfill Under and Around Structures

Under Facilities: Backfill with earthfill or structural fill, as shown on the Drawings, for each structure or facility. Place earthfill or structural fill in lifts of 6-inch maximum compacted thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698.

Fill

Outside Influence Areas Beneath Structures, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

Allow for 6-inch thickness of topsoil where required.

Maximum 8-inch thick lifts.

Place and compact fill across full width of embankment.

Compact to minimum 95 percent relative compaction.

Replacing Overexcavated Material

Replace excavation carried below grade lines shown as follows:

Beneath IDF Cell: Earthfill as specified herein.

Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

Beneath Structures and Roadways: Structural fill or earthfill as shown on the Drawings and specified herein.

Topsoil

Place topsoil on areas disturbed by construction and on permanent stockpile slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Stockpiling

Material shall be placed in permanent stockpiles as follows:

Place material in maximum 3-foot lifts and compact with a minimum four passes with earth-moving equipment. Uniformly route hauls truck traffic across the surface of each lift to aid in lift compaction.

Maximum slopes shall be 3H:1V. Minimum slopes shall be 3 percent to promote drainage.

Upper 2 feet of stockpile surface shall be placed in maximum 12-inch thick lifts and compacted to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

Place 6-inch thick layer of topsoil on completed slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Permanent stockpiles shall be seeded, fertilized, and mulched when each stockpile is completed and as directed by the Engineer in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Placing Crushed Surfacing

Place crushed surfacing base course and top course at locations shown on the Drawings. Placement shall conform to Section 4-04.3 of the Standard Specifications.

Thickness of the drain gravel on the cell floor shall be a minimum of 1.0 foot (increase drain gravel thickness in vicinity of LCRS collection and riser pipes as shown on drawings) and tolerances for the top of the drain gravel shall be grade to plus 0.2 foot.

Placing Drain Gravel And Operations Layer Over Geosynthetics

Place material over geosynthetics as specified in Sections 02371, GEOTEXTILES; 02661, GEOMEMBRANES; and 02667, GEOSYNTHETIC CLAY LINER (GCL).

Compaction requirements for drain gravel on the cell floor, around pipes, and the sumps are specified in Section 02320, TRENCH BACKFILL.

Operations layer within lining system limits, except as specified for SLDS sump area, shall be placed in 12-inch thick lifts and track-walked into place with a minimum two passes with a Caterpillar D6M-

LGP or equal. Operations layer material within SLDS sump area shall be placed in 12-inch thick lifts and compacted to 90 percent relative compaction. Operations layer placed outside edge of liner, such as for shine berm, shall be placed in maximum 8-inch thick lifts and compacted to 95 percent relative compaction.

Place material to the lines and grades shown and compact by tracking a minimum two passes with spreading equipment. Thickness of the operations layer shall be a minimum 3 feet and tolerances for top of operations layer shall be grade to plus 0.3 foot.

Quarry Spalls Placement

Quarry spalls shall be placed around the ends of stormwater pipes to provide erosion protection in accordance with the Plans and as directed by the Engineer. Quarry spalls shall be placed in such a manner that all relatively large stones are essentially in contact with each other and voids are filled with the finer materials to provide a well graded compact mass. Finished surface shall be free from irregularities. The stone shall be dumped on the ground in a manner that will ensure the stone attains its specified thickness in one operation. When dumping or placing, care shall be used to avoid damaging the underlying material. Stone shall not be dumped from height greater than 12 inches above surface. Material placement shall be started from the bottom of the installation, working toward edges. Geotextile damaged during the placement of quarry spalls shall be repaired at Construction General Contractor’s sole expense.

Construction Quality Control

The Construction General Contractor shall perform in-place density and moisture content tests with own qualified personnel or with a qualified independent testing laboratory as specified in paragraph CONSTRUCTION QUALITY ASSURANCE, to be observed by the Construction Manager, on the following minimum schedule:

Material Placed by Stockpile (Upper 2 Feet): One per 10,000 ft^2 per lift.

Construction General Contractor shall submit qualifications of personnel or independent testing laboratory that will perform construction quality control.

END OF SECTION 02315

SECTION 02316 – EXCAVATION SCHED. A & B

Part 1 – General

Work Included

This section describes all excavation necessary for completion of the Project, including excavation for structures, pipe trenches, and leachate sumps.

References

The following is a list of standards, which may be referenced in this section:

Code of Federal Regulations (CFR)

29 CFR 1926 OSHA Safety and Health Regulations for Construction; Subpart P – Excavations

Excavation Support And Safety

Install and maintain adequate excavation safety and shoring systems that meet the requirements of OSHA (29 CFR 1926 Subpart P) and Washington Industrial Safety and Health Act, Chapter 49.17 RCW and WAC 296-155, "Safety Standards for Construction Work" Part IV-Excavation, Trenching and Shoring, and all other applicable local, state, and federal regulations.

Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work. Per OSHA requirements, 29 CFR 1926.652 requires that custom shoring installations shall be designed and stamped by a professional engineer licensed in the State of Washington.

Weather Limitations

Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

Permit Requirements:

An excavation permit is required for each excavation work element. Construction General Contractor shall obtain from Tank Farm Contractor and post before starting excavation work, as specified in Division 1, General Requirements.

Part 2 – Products (Not Used)

Part 3 – Execution

General

Generally, excavate to lines, grades, and dimensions shown and as necessary to accomplish work. Excavate subgrade to within tolerance of minus 0.5 foot to plus 0.1 foot except where dimensions or grades are shown or specified as maximum or minimum.

If unexpected, debris foreign material of any kind (e.g., contaminated soil) or cultured properties (e.g., bones and artifacts) is exposed or encountered during excavation, the Construction General Contractor shall stop work in the affected area and notify the Construction Manager. Obtain approval from Construction Manager before resuming excavation.

Control dust from excavation activities as specified in approved Dust Control Plan. See Section 02200, SITE PREPARATION, for Dust Control Plan requirements.

If soft or loose subgrade zones are encountered at the bottom of the excavation after proof rolling, correct as specified in Section 02319, SUBGRADE PREPARATION.

Structure Excavation

Excavations for such structures as footings, foundations, slabs, and manholes shall be made to the depths shown on the Drawings and of sufficient width to allow adequate room for placement of structural fill setting and removing forms, installing accessories and inspection. Care shall be taken to prevent disturbing the bottom of the excavation. Excavation to final grade shall not be made until just before concrete forms are to be placed therein. Prepare bottom of structure excavation as specified in Section 02319, SUBGRADE PREPARATION, prior to placement of concrete foundations.

Trench And Sump Excavation

Trenches and sumps shall be of sufficient width to provide adequate room for workmen to perform any necessary service to the materials or items being installed therein and to permit proper compaction of the backfill.

Minimum Width of Trenches: As shown on Drawings.

Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

If wet or otherwise unsatisfactory soil is encountered in a trench excavation, at or below the trench bottom, it shall be brought to the attention of the Construction Manager and removed as directed. The bottom of the excavation shall then be brought to the required grade with stabilization as specified in Section 02320, TRENCH BACKFILL.

Temporary Stockpile Excavation

Always keep stockpile neat and orderly and work there in a systematic manner. Take necessary precautions to maintain existing erosion control measures and prevent offsite sediment releases.

When work is completed in the stockpile area, grade area to drain surface water runoff to appropriate collection and discharge points. Reclaim disturbed areas of stockpile as specified in Sections 02315, FILL AND BACKFILL, and 02920, RECLAMATION AND REVEGETATION.

Stockpiling Excavated Material

Stockpile excavated material that is suitable for use as embankment or backfill, as operations layer material, road gravel, or drain gravel, until material is needed. Place materials in stockpiles at the designated locations shown on the Drawings. Materials shall be placed in stockpiles as specified in Section 02315, FILL AND BACKFILL.

Confine stockpiles to within areas shown on Drawings. Do not obstruct roads or streets. Stockpiles should maintain clearance from existing permanent monitoring wells and disposed cribs as shown on the Drawings.

Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads. The registered professional engineer responsible for the shoring design shall approve stockpile locations.

Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed work, if weight of stockpiled material could induce excessive settlement. The registered professional engineer responsible for the shoring design shall approve stockpile locations.

Disposal of Spoil

Dispose of excavated materials, which are unsuitable or not needed for fill or backfill, in designated stockpile areas shown on the Drawings, or spoil disposal areas as directed by Construction Manager. Materials shall be placed as specified in Section 02315, FILL AND BACKFILL.

Trench Excavation For Geosynthetic Anchor Trenches

Geosynthetic anchor trench excavation shall be as specified in Section 02661, GEOMEMBRANES.

Construction Quality Control

Construction General Contractor provides adequate survey control to avoid unauthorized over excavation.

END OF SECTION 02316

SECTION 02317 – BORROW AREA EXCAVATION SCHED. B

Part 1 – General

Work Included

This section describes requirements for borrow excavation from the Admix Base Soil Borrow Area as a source of base soil for the admix. The Admix Base Soil Borrow Area is located within the IDF site boundary approximately 1,000 feet south of the Phase I area as shown on the Drawings.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Borrow Area Development Plan: Detailing development, operation, dust and erosion, mitigation measures, and reclamation of each borrow area.

Part 2 – Products (Not Used)

Part 3 – Execution

General

Clear, grub, and strip only areas actually needed for borrow within limits shown or specified.

Do not injure or deface vegetation that does not require removal.

Clearing, Grubbing, Stripping, And Disposal:

Clearing, grubbing, and stripping shall meet the requirements of Section 02200, SITE PREPARATION.

Disposal

Clearing and Grubbing Debris: As specified in Section 02200, SITE PREPARATION.

Strippings: As specified in Section 02200, SITE PREPARATION.

Borrow Area Operation

Borrow area shall be developed and operated in accordance with the mitigation measures identified in the approved Borrow Area Development Plan and these Specifications.

Always keep borrow pits neat and orderly, and work them in systematic manner. Continuously keep borrow pits graded to drain to a low point, and take necessary precautions to control erosion and prevent offsite sediment releases. Dewater as necessary to develop, operate, and reclaim each borrow area. Control dust as specified in approved Dust Control Plan. See Section 02200, SITE PREPARATION, for Dust Control Plan requirements.

Material meeting the requirements for base soil as specified in Section 02666, ADMIX LINER, shall be excavated from the Borrow Area. Base soil should not be obtained below a depth of 5 feet below existing ground surface (after stripping) without evaluation of the material suitability and authorization from the Construction Manager.

Do not excavate more borrow material than required for work. Leave surplus material in place.

Excavate material in an orderly manner to avoid inclusion of unacceptable material.

Reclamation

At the completion of borrow area excavation, grade borrow pits to drain to low point so that ponded surface water may be removed by pumping. Where practical, blend graded surfaces neatly with surrounding terrain at completion of borrow operations.

Final Slopes:

Maximum: 4H: 1V.

Minimum: 2 percent.

Do not use borrow pits for disposal, unless otherwise specified or shown.

Place 6-inch thick layer of topsoil and seed, fertilize, and mulch all disturbed areas as specified in Section 02920, RECLAMATION AND REVEGETATION.

END OF SECTION 02317

SECTION 02319 – SUBGRADE PREPARATION SCHED. B

Part 1 – General

Work Included

This section describes requirements for preparation of subgrades in areas to receive fill.

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

Definitions

Optimum Moisture Content: As defined in Section 02315, FILL AND BACKFILL.

Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

Relative Compaction: As defined in Section 02315, FILL AND BACKFILL.

SLDS: Secondary Leak Detection System.

Subgrade: Layer of existing soil after completion of excavation to grade prior to placement of fill, roadway structure, or base for floor slab.

Proof Rolling: Testing of subgrade as specified herein to identify soft or loose zones requiring correction.

Sequencing And Scheduling

Complete applicable Work specified in Section 02316, EXCAVATION, prior to subgrade preparation.

Construction Quality Assurance

The CQA Certifying Engineer shall determine in-place density and moisture for subgrade preparation as specified in Section 02315, FILL AND BACKFILL, except for prepared subgrade for admix on sideslopes.

CQA requirements for geomembrane subgrade preparation are specified in Section 02661, GEOMEMBRANES.

Part 2 – Products (Not Used)

Part 3 – Execution

General

Keep subgrade free of water, debris, and foreign matter during compaction or proof rolling.

Bring subgrade to proper grade and cross-section as shown on the Drawings, and uniformly compact surface.

Maintain prepared ground surface in finished condition until next course is placed.

Prepared Subgrade For Roadway, Embankment, And Structures

After completion of excavation and prior to foundation, road fill, structural fill, or embankment construction, compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a fully loaded dump truck or equal to detect soft or loose subgrade or unsuitable material.

Landfill Bottom Floor Prepared Subgrade For Admix Liner

Prior to admix liner placement, subgrade shall be back bladed to remove loose soil. Low spots or erosion rills shall be backfilled with structural fill as specified herein. Compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a vibratory drum roller or equal to detect soft or loose subgrade or unsuitable material.

Landfill Sideslope (3h: 1v) Prepared Subgrade For Admix Liner

Prior to admix placement, the subgrade shall be back bladed to remove all loose material produced by trimming operations. Low spots or erosion rills shall be backfilled with structural fill as specified herein. The trimmed surface shall be watered so that moisture penetrates a minimum of 3 inches into the subgrade. The trimmed and watered surface shall be track-walked by D6-LGP dozer or equivalent with a minimum 4 passes to produce a firm and stable subgrade. Visual monitoring (no in-place density testing is required) of the subgrade preparation on sideslopes will be performed by the CQA Certifying Engineer.

Prepared Subgrade For Geomembrane (Secondary and SLDS) and Secondary GCL

At completion of SLDS excavation and grading (SLDS geomembrane) or admix liner placement (secondary geomembrane and GCL), prepare the subgrade surface for geomembrane or GCL placement. The surface shall not have holes, depressions more than 1 inch in a 12-inch width, nor protrusions extending above the surface more than 1/2 inch. Roll surface with smooth-drum roller to form a firm stable base. Allow for leachate piping and sumps or features as shown on the Drawings.

Correction

Soft or Loose Subgrade: Adjust moisture content and compact to meet density requirements, or

Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL.

Unsuitable Material: Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL. Dispose of unsuitable material excavation in accordance with Article DISPOSAL OF SPOIL in Section 02316, EXCAVATION.

END OF SECTION 02319

SECTION 02320 – TRENCH BACKFILL SCHED. A & B

Part 1 – General

Work Included

This section describes requirements for backfilling of trenches for pipe, conduit, and geosynthetics.

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Definitions

Pipe Bedding: Granular material upon which pipes, conduits, cables, or duct banks are placed.

Imported Material: Material obtained by the Construction General Contractor from source(s) offsite.

Lift: Loose (uncompacted) layer of material.

Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

Submittals–Approval Not Required

Vendor Information (VI): Locator ribbon product data.

Part 2 – Products

Locator Ribbon

Ribbon shall be 3 inches wide and shall be red for all electrical conduits, electrical cables, and telephone cables. Blue locator ribbon shall be used for all buried pipe in the raw water system. Yellow locator ribbon shall be used for the electrical duct bank from riser pole to the transformer. Purple locator ribbon shall be used for the buried leachate transfer lines.

Ribbon shall be tape manufactured by Reef Industries or Allen Markline or equal and shall have metal foil, which is completely encased in plastic and can be easily detected by metal detectors.

The ribbon shall be printed with the manufacturer's standard wording, "CAUTION ELECTRIC LINE BURIED BELOW", for all electrical conduits, phone lines, etc., "CAUTION BURIED PIPELINE BELOW", for all buried pipelines.

Trench Stabilization Material

Granular material from the excavation or stockpile meeting the requirements of structural fill as specified in Section 02315, FILL AND BACKFILL.

Pipe Bedding

Pipe bedding material for thermoplastic pipe shall be clean sand/gravel mixture free from organic matter and conforming to the following gradation:

Sieve Size	**Percent Passing**
3/4″ square	100
3/8″ square	70-100
U.S. No. 4	55-100
U.S. No. 10	35-100
U.S. No. 20	20-80
U.S. No. 40	10-55
U.S. No. 100	0-10
U.S. No. 200	0-5

All percentages are by weight.

Pipe Zone Material

Excavated granular material from required excavations, free from rocks, roots, and organic matter. The maximum particle size shall be 3/4 inch and the percent by weight passing the No. 200 U.S. sieve shall be a maximum 15 percent.

Pipe bedding may be used as substitute for pipe zone material.

Earth Backfill

Earthfill as specified in Section 02315, FILL AND BACKFILL.

Structural Fill

As specified in Section 02315, FILL AND BACKFILL.

Source Quality Control

As specified in Section 02315, FILL AND BACKFILL.

Part 3 – Execution

Trench Preparation

Water Control:

Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.

Remove water in a manner that minimizes soil erosion from trench sides and bottom.

Provide continuous water control until trench backfill is complete.

Remove foreign material and backfill contaminated with foreign material that falls into trench.

Trench Bottom

Firm Subgrade: Remove loose and disturbed material and trim off high areas and ridges left by excavating equipment. Tamp to provide a firm and unyielding subgrade. Allow space for bedding material if shown or specified.

Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of over excavation, if any, required.

Trench Stabilization Material Installation

Rebuild trench bottom with trench stabilization material.

Place material over full width of trench in 8-inch maximum, loose measurement lifts to required grade, providing allowance for bedding thickness.

Compact each lift to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

Bedding

Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

Hand grade and compact each lift to provide a firm, unyielding surface.

Minimum Compacted Thickness: As shown on the Drawings. For leachate collection and riser pipes, there shall be no bedding between lining system and pipe.

Direct-Buried Cable: 3 inches.

Duct Banks:

2 inches.

Check grade and correct irregularities in bedding material.

Backfill Pipe Zone

Upper limit of pipe zone shall not be less than following:

Pipe: 12 inches, unless shown otherwise.

Conduit: 3 inches, unless shown otherwise.

Direct-Buried Cable: 3 inches, unless shown otherwise.

Duct Bank:

3 inches, unless shown otherwise.

Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

Place pipe zone material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

Pipes 10 Inches and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.

Pipes Over 10-Inch Diameter:

Maximum 8-inch, loose measurement lifts.

Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

Do not use power-driven impact compactors to compact pipe zone material.

Locator Ribbon Installation

Continuously install locator ribbon along centerline of all buried piping, at depth of 16 inches below ground surface unless shown otherwise on the Drawings. Coordinate with piping installation drawings.

Backfill Above Pipe Zone

General

Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe. Trench backfill using water-settling methods for compaction is not permitted.

Do not use power driven impact type compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Hand-held jump jack type compactors are acceptable for compaction of backfill over top of pipe.

Backfill to grade with proper allowances for topsoil, road gravel subbase, and pavement thicknesses, wherever applicable.

Backfill around structures with same backfill as specified for adjacent trench unless otherwise shown or specified.

Backfill outside the Limits of Roadways, Utilities, and Other Facilities:

Place earthfill in lifts not exceeding 12-inch maximum, loose measurement thickness.

Mechanically compact each lift to a minimum of 90 percent relative compaction prior to placing succeeding lifts.

Backfill Under Facilities, Roadways, and Utilities: Backfill trench above the pipe zone with structural fill in lifts not exceeding 8 inches maximum, loose measurement thickness. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

Replacement of Topsoil

Where applicable, replace topsoil in top 6 inches of backfilled trench.

Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

Drain Gravel Backfill For Leachate Collection (Slotted) Pipe, Riser Pipes, And Sumps

Use drain gravel as specified in Section 02315, FILL AND BACKFILL.

Drain gravel shall be placed in sumps by mechanical or hand methods that will not damage pipes or underlying geosynthetics. For areas within 3 feet of leachate collection pipe, riser pipe, and transducer pipe centerline, the Construction General Contractor shall place first lift of drain gravel on both sides of pipe in a 9-inch lift, and succeeding lifts shall be 6 inches maximum. The Construction General Contractor shall thoroughly tamp each lift, including area under haunches with handheld equipment and tools to ensure that voids are completely filled before placing each succeeding lift. After first lift and after the full depth of material has been placed as specified, the Construction General Contractor shall compact the material by a minimum of three passes with a hand-held vibratory plate compactor only over the area within 3 feet of pipe centerline.

For LDS Drain Gravel placement within the LDS Sump, outside of 3 feet from the leachate collection pipe centerline, material will be placed in 6-inch maximum lifts and compacted in lifts with a minimum of three passes of the hand-held plate compactor to ensure that firm and unyielding conditions are achieved throughout the entire gravel thickness in the sump. At all other locations, drain gravel shall be track-walked into place with a minimum two passes with a D6M-LGP bulldozer or equal. Equipment limitations and requirements for placing materials over geosynthetics are specified in Section 02315, FILL AND BACKFILL.

Backfill For Geosynthetic Anchor Trenches

Backfill with material as shown on the Drawings in loose lifts not exceeding 6 inches in thickness and compact using hand-operated equipment or mechanical equipment as approved by the Design Engineer to not less than 90 percent relative compaction.

Construction Quality Control

The Construction General Contractor shall perform in-place density and moisture content tests as specified in Section 02315, FILL AND BACKFILL, to be observed by the Construction Manager, on the following minimum schedule:

Backfill Above Pipe Zone: One per 500 linear feet per lift.

Maintenance of Trench Backfill

After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

Settlement of Backfill:

Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION 02320

SECTION 02371 – GEOTEXTILES SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D3776	Standard Test Method for Mass per Unit Area (Weight) of Fabric
ASTM D4355	Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Method for Determining Apparent Opening Size
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

Description

The Work includes manufacture, fabrication (if needed), supply, and installation of geotextiles associated with the lining of the disposal facility and other applications as shown on the Drawings. This section also applies to geotextiles used in geocomposite drainage layers [see Section 02373, COMPOSITE DRAINAGE NET (GEOCOMPOSITE)].

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Manufacturer's Quality Control (QC) test data for geotextile physical properties, verifying compliance with these Specifications. Data shall include test results, methods, and roll numbers. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan.

Manufacturer's written certification that materials meet the requirements of these Specifications and that geotextile is continuously inspected for presence of needles and found to be needle-free.

Construction Quality Assurance (CQA)

Quality assurance procedures for geotextile are presented in the CQA Plan. CQA Plan requirements are discussed in Section 02661, GEOMEMBRANE. The Construction General Contractor shall accommodate all CQA activities described herein and in the CQA Plan for this project.

Prior to placing any materials over the installed geotextile, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA Conformance Testing

Prior to deployment of the rolls of geotextile, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or 50,000 square feet of each material type, whichever results in the greater number of tests. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of certified properties.

As a minimum, the following tests will be performed on geotextiles (each type, except as noted):

Grab Strength: ASTM D4632.

Tear Strength: ASTM D4533.

Puncture Strength: ASTM D4833.

Permittivity: ASTM D4491 (Type 1 only).

The CQA Certifying Engineer shall be allowed to remove samples for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

Part 2 – Products

General

Types of Geotextiles:

Type 1 (separation) geotextile shall be 6 oz/yd^2 nominal weight and shall be used for separation of soil layers, in the geocomposite drainage layers, and at other locations as shown on the Drawings.

Type 2 (cushion) geotextile shall be 12 oz/yd2 nominal weight and shall be used for cushioning of geomembranes and at other locations as shown on the Drawings.

All geotextiles, regardless of type, shall be nonwoven, needle punched polypropylene.

Manufacturer: The geotextile manufacturer shall be a commercial entity normally engaged in manufacture of geotextiles for landfill applications.

Required Properties

Property Values:

Geotextile properties shall meet or exceed the values specified in Table 1, Required Geotextile Properties, contained in this section of the Specifications (Type 1 and Type 2 geotextiles).

The manufacturer shall provide test results for all properties listed in Table 1 (Type 1 and Type 2 geotextiles).

The manufacturer shall certify that the materials supplied meet the requirements of this Part (Type 1 and Type 2 geotextiles).

Integrity: Geotextiles shall retain their structure during handling, placement, and long-term service.

Transportation, Handling, and Storage

Geotextiles shall be supplied in rolls wrapped in covers and marked or tagged with the roll number. Each material roll shall include information to demonstrate material traceability through written documentation from the manufacturer and transport company. At a minimum, this information shall include the Manufacturer's Name, Product Identification, Lot Number, and Roll Dimension (Area and Width).

Transportation of the geotextiles to the site and all handling on site shall be the responsibility of the Construction General Contractor.

During shipment and storage, the geotextile shall be protected from mud, dirt, UV exposure, dust, puncture, cutting, or other damaging or deleterious conditions. Protective wrappings, which are damaged, shall be repaired or replaced, as necessary.

The Construction General Contractor shall be responsible for the storage of the geotextiles on site within the areas shown on the Drawings. The Construction General Contractor shall protect storage area(s) from theft, vandalism, passage of vehicles, etc.

Part 3 – Execution

General

Unacceptable Materials and Work: Materials and Work, which fail to meet the requirements of these Specifications, shall be removed and disposed of at the Construction General Contractor's expense. This includes geotextile rolls that are not labeled or where the label has deteriorated to the point of being illegible.

Handling And Placement

The Construction General Contractor shall handle all geotextiles in such a manner as to ensure that they are not damaged. Geotextile will be deployed on top of textured HDPE geomembrane in a manner that will not damage the geotextile. If necessary, use a smooth slip-sheet under the geotextile.

Place geotextiles in a manner that prevents folds and wrinkles. Folds or wrinkles shall be pulled smooth prior to seaming.

In the presence of wind, all exposed geotextiles shall be weighted with sandbags or equivalent. Sandbags shall be installed during placement and shall remain until replaced with cover material.

Geotextiles shall be cut using an approved geotextile cutter only. Special care shall be taken to protect underlying geosynthetic materials from damage during cutting.

During geotextile placement, care shall be taken not to entrap stones, excessive dust, or moisture that could damage the geomembrane, clog drains or filters, or hamper subsequent seaming.

Geotextiles shall be placed with the machine direction (long dimension) downslope or normal to the natural slope.

After installation and immediately prior to placing overlying materials, the geotextile shall be examined over its entire surface to ensure that no potentially harmful foreign objects, such as needles, are present. Any foreign objects encountered shall be removed, or the geotextile shall be replaced.

If light colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

After deployment, all geotextile shall be covered to prevent exposure to ultraviolet (UV) radiation (sunlight) within a maximum period of 14 days. If the geotextile is exposed for more than 14 days, a temporary cover may be deployed for the duration of the delay or samples may be submitted to an independent testing laboratory to ensure that detrimental levels of UV degradation have not occurred. Detrimental level of UV degradation is defined as greater than 10 percent loss of required geotextile properties listed in Table 1 for the following:

Grab strength.

Trapezoidal tear strength.

Puncture strength.

Joints

Edge of roll seams are not required to be sewn and shall be overlapped a minimum of 6 inches. End of roll seams are not required to be sewn and shall be overlapped a minimum of 12 inches. No end-of-roll seams shall be allowed on slopes 6H:1V and steeper. Overlaps shall be in the direction of flow with the upstream fabric on top of the downstream fabric.

On the landfill floor, no horizontal seam shall be closer than 3 feet to the toe of the slope or other areas of potential stress concentrations.

Areas to be seamed shall be clean and free of foreign material.

Repair

Any holes or tears in the geotextile shall be repaired as follows:

Remove any soil or other material, which may have penetrated the torn geotextile.

Replace torn areas and holes by placing a geotextile patch having dimensions of at least 12 inches greater than the tear or hole. The geotextile patch shall be sewn or heat bonded.

For repairs of the geotextile component of the CDN, a patch shall be heat bonded.

Materials In Contact With Geotextiles

The Construction General Contractor shall place all soil materials located on top of a geotextile in such a manner as to ensure that the following conditions are satisfied:

No damage to the geotextile.

Minimal slippage of the geotextile on underlying layers.

No excess tensile stresses in the geotextile.

END OF SECTION 02371

Table 1. Required Geotextile Properties

Value[(a)]

Property	Unit	Type 1	Type 2	Test Method
Mass/Unit Area	oz/yd^2	6.0[(b)]	12.0[(b)]	ASTM D5261 or D3776
Apparent Opening	U.S. Sieve	70 max opening	—	ASTM D4751
Size[(b)]		100 min opening		
Grab Strength	lb	140	300	ASTM D4632
Trapezoidal Tear				
Strength	lb	70		110
ASTM D4533				
Puncture Strength	lb	65	135	ASTM D4833
Permittivity	sec^{-1}	1.2	—	ASTM D4491
UV Resistance % strength	(500 hours)	retained 70	70	ASTM D4355

Notes:

[(a)]All values are minimum average values, except as noted. [(b)] Nominal values.

SECTION 02373 – COMPOSITE DRAINAGE NET (CDN) SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D413	Standard Test Method for Rubber Property Adhesion to Flexible Substrate
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D1777	Standard Test Method for Measuring Thickness of Textile Materials
ASTM D4218	Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI-GC7	Determination of Adhesion and Bond Strength of Geocomposites description:

The work includes manufacture, fabrication (if needed), supply, and installation of geocomposite (hereinafter referred to as composite drainage net (CDN)) drainage layers associated with the lining of waste disposal facility. The CDN shall consist of a layer of geotextile thermally bonded to each side of a geonet. Requirements for geotextiles are contained in Section 02371, GEOTEXTILES, of these Specifications. Requirements for geonets and the finished CDN are contained in this section.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Construction General Contractor shall submit required interface strength data, as specified in PART 2-PRODUCTS, prior to shipment of material to allow Engineer to evaluate if submitted material meets strength requirements for project design criteria. Allow Engineer 20 working days for this evaluation upon receipt of data.

Installation Plan: The Construction General Contractor shall submit a plan describing the proposed methods for CDN deployment, panel layout, seaming, repair, and protection. The plan shall include a quality assurance program for the Construction General Contractor's activities related to CDN installation.

Manufacturer's Quality Control (QC) test data for CDN composition and physical properties, verifying compliance with these Specifications. The data shall include roll numbers, test results, and test methods. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan.

Manufacturer's written certifications that CDN satisfy the requirements of these Specifications.

Construction Quality Assurance (CQA)

Quality assurance procedures for CDN installation are presented in the Construction Quality Assurance Plan (CQA Plan). CQA Plan requirements are discussed in Section 02661, GEOMEMBRANE. The Construction General Contractor shall accommodate all quality assurance activities described herein and in the CQA Plan for this project.

Prior to placing any materials over the installed CDN, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA conformance testing: Upon delivery of the rolls of geonet and CDN, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or one per 50,000 square feet of each material type, whichever results in the greater number of tests; transmissivity shall be as noted below. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of certified properties.

CDN fabricated from non-conforming components shall be rejected at the Construction General Contractor's expense.

As a minimum, the following tests will be performed on geonets:

Polymer specific gravity (ASTM D1505).

Thickness (ASTM D5199).

Nominal transmissivity (ASTM D4716 – one per production lot).

As a minimum, the following tests will be performed on CDNs:

Adhesion (GRI-GC7 or ASTM D413).

Transmissivity (ASTM D4716 – one per production lot).

The CQA Certifying Engineer shall be allowed to remove samples of geonet and CDN for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

Part 2 – Products

General

Composition: The geonet shall be high-density polyethylene (HDPE), manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

The CDN shall consist of Type 1 geotextile thermally bonded to each side of the HDPE geonet.

Manufacturer: The CDN manufacturer shall have a minimum of 5 years' experience as a commercial manufacturer of CDNs for landfill drainage applications.

Required Properties

Property Values

Geonet: Geonet properties shall meet or exceed the values specified in the table of required geonet properties contained in this section of the Specifications.

Geotextile: Geotextile properties shall meet or exceed the values specified in Section 02371, GEOTEXTILES, of these Specifications unless otherwise approved by the Engineer.

Finished CDN: CDN properties shall meet or exceed the values specified in the table of required CDN properties contained in this section of the Specifications.

Required Interface Shear Strength Data:

Provide data prior to material shipment for the interface friction angle between the CDN and textured geomembrane, and between the CDN and operations layer material, as specified in Article SUBMITTALS. Perform two interface shear strength tests on each interface. Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321) at nominal normal loads of 100, 250, and 500 psf. Report results for both peak and large displacement (minimum 2 inches) strength.

The Engineer will review this data for conformance with project design strength requirements. Construction General Contractor shall not order material for shipment until approved by Engineer. Any product or material changes required as a result of inadequate strength data will be addressed by Change Order provided submitted material meet all other requirements of this section.

Manufacturer's Information: The manufacturer shall provide specification sheets, literature, and test results for all properties listed in these Specifications. The manufacturer shall certify that the materials supplied meet the requirements of this Part.

Integrity: Geonets and CDNs shall retain their structure during handling, placement, and long-term service.

Transportation, Handling, and Storage

Geonets and CDNs shall be supplied in rolls wrapped in covers and marked or tagged with the roll number. Each material roll shall include information to demonstrate material traceability through written documentation from the manufacturer and transport company. At a minimum, this information shall include the Manufacturer's Name, Product Identification, Lot Number, and Roll Dimension (Area and Width).

Transportation of the CDN to the site and all handling on site will be the responsibility of the Construction General Contractor.

During shipment and storage, the geonet and CDN shall be protected from mud, dirt, UV exposure, dust, puncture, cutting, or other damaging or deleterious conditions. Protective wrappings, which are damaged, shall be repaired or replaced, as necessary.

The Construction General Contractor shall be responsible for the storage of the CDN on site within the limits of construction. The Construction General Contractor shall protect storage area(s) from theft, vandalism, passage of vehicles, etc.

Part 3 – Execution

General

Unacceptable Materials and Work: Materials and Work, which fail to meet the requirements of these Specifications, shall be removed, disposed of, and replaced at the Construction General Contractor's expense.

Handling And Placement

The Construction General Contractor shall handle all CDNs in such a manner as to ensure that these materials are not damaged.

Clean geomembrane surface prior to placing CDN.

On slopes, CDN may be deployed over slip-sheets with the roll at the top of the slope. An alternative method is to secure the CDN and then roll it down slope in a manner to continually keep it in tension. If necessary, position the CDN after deployment to minimize wrinkles and remove the slip-sheet, if used.

Do not drag the CDN across textured geomembrane in any way that damages the geotextile component or reduces the friction at the geomembrane/CDN interface.

In the presence of wind, all exposed CDNs shall be weighted with sandbags or equivalent. Sandbags shall be installed during CDN placement and shall remain until replaced with cover material.

Unless otherwise specified, CDNs shall not be welded to geomembranes.

CDNs shall only be cut using approved cutting tools. Protect underlying geosynthetics when cutting.

The Construction General Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the CDN.

During placement of CDNs, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. Dirt or excessive dust entrapped in the CDN shall be cleaned prior to placement of the next material on top of it. Excessive dust is defined as any thickness greater than 20 mils (0.02 inch) within the geonet core of the CDN. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag.

Tools shall not be left in the CDN.

After deployment, all CDN shall be covered within a maximum period of 14 days to prevent exposure of geotextile component to ultraviolet (UV) radiation (sunlight). See Section 02371, GEOTEXTILES, for requirements of geotextile exposed to UV radiation longer than 14 days.

Joining

Adjacent sections of CDN shall be overlapped according to the manufacturer's directions.

Overlaps shall be secured by spot welding or tying. Acceptable tying devices include strings, plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy observation. Metallic devices are not allowed.

Overlaps shall be secured every 5 feet along slopes and on the floor of the landfill. Overlaps shall be secured every 6 inches in anchor trenches. Along end-to-end seams, spot-weld, or tie each row at 6-inch intervals; stagger weld or ties between rows.

In joining CDNs, tearing the geotextile away from the geonet shall only be allowed at panels ends in order to seam same material components together and shall be minimized to the extent necessary to perform the required work.

No horizontal seams shall be allowed on side slopes except at roll ends.

If more than one layer of CDN is installed, joints shall be staggered.

Repair

Remove the damaged area of CDN.

Cut a piece of geonet to fit into the repair area. Geonet shall fit into repair area to form a flush surface with the CDN. Cut geonet so that ribs are in the same orientation as existing CDN.

Remove any dirt or other foreign material, which may have entered the CDN.

Place CDN patch over damaged area. Geonet component of patch shall be tied to in-place geonet component according to manufacturer's recommendations.

Place Type 1 geotextile over the exposed geonet component with an overlap of 4 inches of geotextile. Heat seam repair geotextile to existing geotextile.

Materials in Contact With CDNs

The Construction General Contractor shall place all soil materials located on top of a CDN layer in such a manner as to ensure that the following conditions are satisfied:

No damage to the CDN.

No slippage of the CDN on underlying layers.

No excess tensile stresses in the CDN.

END OF SECTION 02373

Table 1. Required Geonet Properties

Property	Qualifier	Unit	Value	Test
Polymer Composition	Minimum	% polyethylene	95	---
Resin Specific Gravity	Minimum	N/A	0.92	ASTM D1505
Carbon Black Content	Range	%	2 - 3	ASTM D1603 or D4218
Nominal Thickness	MARV	mils	250	ASTM D1777 or D5199
Nominal Transmissivity(1)	MARV	m^2/sec	3×10^{-3}	ASTM D4716

Table 2. Required CDN Properties

Property	Qualifier	Unit	Value	Test
Ply Adhesion	ARV	lb/in	1.0	ASTM D413 or GRI-GC7
Transmissivity(1)	MARV	m^2/sec	5×10^{-4}	ASTM D4716

Notes:

MARV = Minimum Average Roll Value.

ARV = Average Roll Value.

(1)The design transmissivity is the hydraulic transmissivity of the CDN measured using water at 70 degrees F ±3 degrees F with a hydraulic gradient of 0.1, under the compressive stress of 10,000 psf. Transmissivity value shall be measured between two steel plates 15 minutes after application of the confining stress in the machine direction.

SECTION 02500 – RAW WATER CONVEYANCE PIPING – GENERAL SCHED. A & B

Part 1 – General

Summary

This section is for furnishing and installing raw water piping and associated components.

References

The following is a list of standards, which may be referenced in this section:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Standard Specification for Structural Concrete

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm), for Water and Other Liquids
AWWA C115/A21.15	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C217	Cold-Applied Petroleum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried Steel Water Pipelines
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C221	Fabricated Steel Mechanical Slip-Type Expansion Joints
AWWA C606	Grooved and Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A497	Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A615/A615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement

NSF INTERNATIONAL (NSF)

NSF 61B	Drinking Water System Components - Health Effects

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information.

Documentation for pipe pressure class.

Submittals–Approval Not Required

Information/Record (IR)

Submit results of pressure leakage testing for raw water conveyance piping.

Submit results for materials and test certificate after completion of the system in accordance with NFPA 24 Chapter 9.

Delivery, Storage, And Handling

In accordance with manufacturer's recommendations.

Marking at Plant:

Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, diameter of pipe, dimension ratio, pipe class, and other information required for type of pipe.

Pipe, specials, and fittings received at Project site in damaged condition will not be accepted.

Gasket Storage:

Store rubber gaskets in cool, well-ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

Handling:

Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workmen. Slings shall bear uniformly against pipe.

Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

Part 2 – Products

Pipe

As specified in Section 02502, RAW WATER DUCTILE IRON PIPE AND FITTINGS, Section 02509, RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS, and the Carbon Steel Pipe and Galvanized Steel Pipe Data Sheets attached to this section.

Joints

As specified in Section 02502, RAW WATER DUCTILE IRON PIPE AND FITTINGS, Section 02509, RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS, and the Carbon Steel Pipe and Galvanized Steel Pipe Data Sheets attached to this section.

Flexible Lock Couplings

General:

Couplings shall be rated for 173 PSI.

Buried, bolted, sleeve-type couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

Locking pins shall be integral to coupling, number and diameter of pins per manufacturer's standard.

For Pipe with Plain-Ends:

Bolted, sleeve-type coupling, in accordance with AWWA C219.

Manufacturer of couplings shall observe same quality control requirements as specified in AWWA C221 for fabrication of pipe expansion joints.

Manufacturers and Products: Dresser; Style 167.

Service Saddles

Double strap type with minimum strap width of 2 inches.

Straps shall be Type 304 stainless steel. Saddles shall be ductile iron, epoxy-coated, 10 mils minimum thickness.

Minimum Pressure Rating: 200 psi.

Flanges, Flange Gaskets, and Bolting Materials

As specified in individual raw water specifications for each piping material.

Concrete For Thrust Blocks

Thrust Block Concrete: As specified in Section 03301, CONCRETE.

Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

Welded Wire Fabric: ASTM A497.

Formwork: Plywood; earth cuts may be used as approved by Construction Manager.

Locator Ribbon

As specified in Section 02320, TRENCH BACKFILL.

Pipe Bedding And Pipe Zone Material

Granular material as specified in Section 02320, TRENCH BACKFILL.

Trench Stabilization Material:

As specified in Section 02320, TRENCH BACKFILL.

Part 3 – Execution

General

Installation shall be in accordance with NFPA 24 Standard for the Installation of Private Service Mains and Their Appurtenances.

Notify Construction Manager at least 2 weeks prior to field fabrication of pipe or fittings.

Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.

Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by Construction Manager. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

Examination

Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer's instructions.

Preparation Of Trench

Prepare trench as specified in Section 02316, EXCAVATION.

Unless otherwise permitted by Construction Manager, maximum length of open trench shall not exceed 500 feet.

Installation

General

Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

Install individual pipe lengths in according to approved lay diagram. Misplaced pipe shall be removed and replaced.

Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.

Flanged Joints: Install perpendicular to pipe centerline.

Bolt Holes:

Straddle vertical centerline, aligned with connecting equipment flanges or as shown on Drawings.

Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.

Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.

Couplings:

Install in accordance with manufacturer's written instructions.

Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.

Remove pipe coating, if necessary, to obtain smooth surface.

Clean gaskets before installation.

If necessary, lubricate with gasket lubricant for installation on pipe ends.

Tighten coupling bolts progressively; drawing up bolts on opposite sides gradually until bolts have uniform tightness.

Buried Pressure Pipe

Placement:

Keep trench dry until pipe laying and joining is completed.

Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.

Excavate trench bottom and sides of ample dimensions to permit proper joining, visual inspection, and testing of entire joint.

Prevent foreign material from entering pipe during placement.

Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

In general, lay pipe upgrade with bell ends pointing in direction of laying.

Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. Pipe joints shall be pushed together in straight alignment and then deflected. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:

- Shorter pipe lengths.
- Special mitered joints.
- Standard or special fabricated bends.
- Check gasket position with feeler gauge to assure proper seating.
- After joint has been made, check pipe alignment and grade.
- Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
- Prevent uplift and floating of pipe prior to backfilling.

Tolerances:

Deflection From Horizontal Line: Maximum 2 inches.

Deflection From Vertical Line: Maximum 1 inch.

Joint Deflection:

Maximum of 75 percent of manufacturer's recommendation.

Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.

Cover Over Top of Pipe: Minimum 3.5 feet, unless otherwise shown.

Disposal of Excess Excavated Material: As specified in Section 02316, EXCAVATION.

Thrust Restraint

Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.

Thrust Blocking

Quantity of Concrete:

Sufficient to cover bearing area of pipe and provide required soil-bearing area as shown on Drawings. For vertical bends, concrete shall be sufficient to provide required volume as shown on Drawings.

Place blocking so pipe and fitting joints are accessible for repairs.

Place concrete in accordance with Section 03301, CONCRETE.

Corrosion Protection

Buried Pipe:

As specified in the individual specifications following this section.

Notify Construction Manager at least 3 days prior to start of surface preparation, coating application, and corrosion protection work.

Placement Of Pipe Locator Ribbon

Place pipe locator ribbon in accordance with Section 02320, TRENCH BACKFILL.

Pipe Bedding And Zone Material

Place pipe bedding and pipe zone material in accordance with Section 02320, TRENCH BACKFILL.

Construction Quality Control

Pressure Leakage Testing for Raw Water Ductile Iron and PVC: As specified in the individual piping Specification(s) following this section.

Pressure Leakage Testing for Raw Water Carbon Steel Pipe and Fittings and Valves Upstream of 12-Inch Gate Valve:

Shop Test: After fabrication of carbon steel spools (as specified in carbon steel pipe supplement at the end of this section) and prior to lining or coating, blind flanges shall be installed on each flange. One blind flange shall be tapped as necessary for a test port. A hydrostatic leak test shall be performed at 173 psig for 30 minutes; no visible leaks shall be allowed.

Field Test: An in-service leak test shall be performed with excavation open. Retighten bolts on fittings/valves as necessary and within manufacturer's recommendations to stop any visible leaks.

Pressure Leakage Testing for Raw Water Galvanized Steel Pipe and Malleable Iron Fittings: Perform in conjunction with leakage test for raw water ductile iron and PVC.

Supplements

Supplement 1—Carbon Steel Pipe and Fittings.

Supplement 2—Galvanized Steel Pipe and Malleable Iron Fittings.

END OF SECTION 02500

1 **Table 1. Carbon Steel Pipe and Fittings**

Item	Size	Description
Pipe	24"	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints: Schedule 20 (24" OD, 0.375" wall thickness) For pressure testing purposes of 24" OD flange x plain end spools, initially construct one flange x flange spool. After completion of pressure testing per Article CONSTRUCTION QUALITY CONTROL of this Specification section, the flange x flange spool shall be cut in half. Each half shall then be coated, lined, and installed per the Drawings. Other flange x flange spools shall be pressure tested prior to coating and lining per Article CONSTRUCTION QUALITY CONTROL.
Joints		Flanged at valves as shown
Flanges		Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 slip-on or welding neck; weld neck bore to match pipe internal diameter. Welding shall conform to AWS D1.1, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict, AWS D1.1 shall govern.
Bolting	All	Carbon steel ASTM A193/A193M, Grade B7 studs and ASTM A194/A194M, Grade 2H hex head nuts. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts and ASTM A563, Grade A heavy hex nuts.
Gaskets	All	General Service and Oil/Gas: 1/16" thick compressed nonasbestos composition flat ring type. Garlock, Style 3000; Manville, Style 978.
Coating		General: Holdback of, and coating shall be as follows: For flex couplings, 8 inches. Epoxy Coating: Coating system for pipe and flanges (except machined surfaces) shall conform to AWWA C210. Paint system for coating shall be Tnemec Series 141 (Color WH03) or approved equal. Completed coating shall have a total dry film thickness of 16 mils minimum. Application of epoxy coatings shall be in accordance with federal, state, and local regulations. Coatings shall be shop-applied, except for field repairs and holdback areas. Materials shall be suitable for temperatures that may be encountered in Project location, and for time of year when materials are being applied and pipeline is being installed. Coating shall be tested in accordance with AWWA C210. Defects shall be repaired in accordance with AWWA C210. Furnish and apply in field, coat tar epoxy paint, Koppers 300M, or equal, on holdback areas after installation of flex couplings and at damaged coating locations.
Lining		Epoxy Lining: Conform to AWWA C210.

Item	Size	Description
		Lining shall be an epoxy system suitable for potable water service (listed by National Sanitation Foundation Standard 61). Paint system for lining shall be Tnemec Series 141 (Color WH03) or approved equal. Completed lining shall have a total dry film thickness of 10 mils minimum.

Table 2. Galvanized Steel Pipe and Malleable Iron Fittings

Item	Size	Description
Pipe		Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	2" and smaller	Schedule 80.
	2-1/2" through 6"	Schedule 40
Joints	All	Threaded or flanged at valves and equipment.
Fittings		Threaded: 150- or 300-pound galvanized malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded malleable iron, ASTM A197 or A47, 300-pound WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Bolting		Flanges: Carbon steel ASTM A307, Grade A hex head bolts, and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
Thread	2" & smaller	Teflon tape or joint compound that is insoluble in
Lubricant		Water

SECTION 02502 – RAW WATER DUCTILE IRON PIPE AND FITTINGS SCHED. A

Part 1 – General

Summary

This section is for furnishing and installing 6-inch ductile iron raw water piping and associated components.

References

The following is a list of standards that may be referenced in this section:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T99	Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5LB) Hammer and a 305mm (12 in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile Iron Pipe Systems
AWWA C110	Ductile Iron and Grey Iron-Fittings, 3-inch through 48-inch
AWWA C111	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
AWWA C115	Flanged Ductile Iron Pipe with Ductile Iron and Grey Iron Fittings
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe. Centrifugally Cast, for Water
AWWA C153	Ductile Iron Compact Fittings, 3-inch through 24-inch and 54-inch through 64-inch for Water Service
AWWA C207	Steel Pipe Flanges for Waterworks Service, Sizes 4-inch Through 144-inch (100mm through 3600mm)
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved End, Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM B16.21	Standard Specification for Nonmetallic Flat Gaskets for Pipe Flanges
ASTM D882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
ASTM D1330	Standard Specification for Rubber Sheet Gaskets

ASTM D1922	Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

DUCTILE IRON PIPE RESEARCH INSTITUTE (DIPRA)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Flushing Procedure: The flushing procedure shall outline the method and materials for handling flush water, i.e., pipe, valves, fittings for filling pipeline and similar for discharging flush water, method for restraining aboveground pipe, and preventing erosion damage.

Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

- Testing dates.
- Piping systems and section(s) to be tested.
- Method of isolation.
- Method of conveying water from source to system being tested.
- Calculation of maximum allowable leakage for piping section(s) to be tested.

Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

As-Built Survey Data: Before final acceptance of raw water piping system, provide as-built locations of systems and components, showing pressure pipelines, including grade breaks or alignment, horizontal and vertical locations of all utility crossings, finished grade profile on all alignments, and valve locations. The submitted data shall be certified by a Washington licensed land surveyor.

Shop Drawings: Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.

Submittals–Approval Not Required

Information/Record (IR): Hydrostatic test documentation form and results.

Part 2 – Products

Materials

Pipe:

General:

- Centrifugally cast, grade 60-42-10 iron.
- Meet requirements of AWWA C150, C153, and C111.
- Lined and coated as specified.

Pipe wall thickness Class 50.

Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 12-inch to 54-inch diameter pipe in accordance with AWWA C115.

Grooved end pipe, for all pipe diameters, shall be minimum Special Class 53.

Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

Joints:

Push-On Joint: Rated at minimum working pressure equal to pipe material design.

Restrained Joint: Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.

Manufacturers and Products:

American Cast Iron Pipe; Flex-Ring and Lok-Ring.

Pacific States Pipe; Thrust-Lock.

U.S. Pipe; TR Flex.

Mechanical Wedge Action Type Joint:

Use only in areas where adjoining to fixed points where laying length is determined in field.

Prior to purchase and installation, type and application of this joint shall be approved by Construction Manager.

Use of setscrews for restraint or field-lock gaskets shall not be allowed.

Flanged Joint: Threaded 250 psi working pressure ductile iron flanges conforming to AWWA C115.

Fittings:

Ductile Iron, Push-On, Flanged, or Restrained Joint: In accordance with AWWA C110, at 250 psi minimum working pressure for 3- to 24-inch fittings and 150-psi minimum working pressure for 30- to 48-inch fittings.

Mechanical Joint Fittings: In accordance with AWWA C111.

Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.

Welded Outlet: Only weld to pipe in manufacturer's shop.

Lining: Pipe and fittings for clean water applications shall be cement lined and asphaltic seal coated in accordance with AWWA C104.

Coating: Asphaltic type, 1 mil thick, in accordance with AWWA C151, C115, C110, and C153.

Bolting: Bolts for flanged connections shall be carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.

Gaskets: Gaskets for flat faced 150 and 250 psi working pressure flanges shall be 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.

Part 3 – Execution

Examination

Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

Preparation

Trench Grade:

Grade bottom of trench by hand to specified line and grade, with proper allowance for pipe thickness and pipe base, when specified. Trench bottom shall form a continuous and uniform bearing and support for pipe between bell holes.

Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.

Bell (Joint) Holes: At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides where necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

Installation

General:

Provide and use proper implements, tools, and facilities for safe and proper prosecution of work.

Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings, and linings.

Do not drop or dump pipe materials into trench.

Cleaning Pipe and Fittings:

Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.

Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

Laying Pipe:

Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Construction Manager.

Mechanical Joint, Push-On Joint, and Restrained Joint Pipe:

After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement.

Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.

When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.

Do not allow foreign material to enter pipe while it is being placed in trench.

Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.

Joining Push-On Joint Pipe and Mechanical Joint Fittings:

Join pipe with push-on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.

Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.

Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.

Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

Cutting Pipe:

General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and to leave a smooth end, at right angles to axis of pipe.

Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.

Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

Field Welding:

Use of field-welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.

Field installed outlets may be installed with saddle approved by Construction Manager. Opening in pipe shall be machined cut and not with cutting torch.

Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

Line and Grade:

Minimum Pipe Cover: 3.5 feet, unless otherwise indicated.

Install pipe to uniform grades and minimize high points.

Maintain pipe grade between invert elevations.

Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Construction Manager.

Pipeline sections that are not installed to elevations shown or installed as approved by Construction Manager shall be reinstalled to proper elevation.

Construction Quality Control

Cleaning:

Following assembly and testing, and prior to final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

If impractical to flush large diameter pipe at 2.5 fps, clean pipe by use of pipe pig as approved by Construction Manager. Multiple passes of pipe pig may be required to adequately clean line.

Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

Pipeline Hydrostatic Test:

General:

Notify Construction Manager in writing 5 days in advance of testing. Construction Manager will coordinate with other parties required to witness testing. Perform testing in presence of Construction Manager.

Test newly installed pipelines. Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.

Furnish testing equipment and perform tests in manner satisfactory to Construction Manager. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.

Isolate new pipelines that are connected to existing pipelines.

Conduct tests on entire pipeline after trench has been backfilled. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

Construction General Contractor may, if field conditions permit and as determined by Construction Manager, partially backfill trench, and leave joints open for inspection and conduct an initial service leak test. Hydrostatic test shall not, however, be conducted until backfilling has been completed.

Procedure:

Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.

Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points.

Test pressure shall be 173 psi as measured at low point of pipeline.

Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.

Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.

Identify method of disposing of water after system testing.

Allowable Leakage: Maximum allowable leakage shall not exceed amount stated in AWWA C600.

END OF SECTION 02502

SECTION 02509 – RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS SCHED. A & B

Part 1 – General

Summary

This section is for furnishing and installing 1-inch and 4-inch Schedule 80 solvent weld, 4-inch and 12-inch bell and spigot, raw water piping and associated components.

References

The following is a list of standards, which may be referenced in this section:

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 inch Through 48 inch (75 mm Through 1200 mm), for Water and Other Liquids
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch Through 12 inch (100 mm Through 300 mm), for Water Distribution
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inches Through 48 inches (350 mm Through 1,200 mm) for Water Transmission and Distribution
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 inch Through 8 inch (100 mm Through 200 mm)
AWWA Manual M23	PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM D1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2467	Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

ASTM D2672	Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
ASTM D2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

NSF INTERNATIONAL (NSF)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Flushing Procedure: The flushing procedure shall outline the method and materials for handling flush water, i.e., pipe, valves, fittings for filling pipeline and similar for discharging flush water, method for restraining aboveground pipe, and preventing erosion damage.

Qualifications:

Solvent Welders: List of solvent welders and current test records for solvent welder(s) for field solvent welding.

Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

- Testing dates.
- Piping systems and section(s) to be tested.
- Method of isolation.
- Method of conveying water from source to system being tested.
- Calculation of maximum allowable leakage for piping section(s) to be tested.

Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

As-Built Survey Data: Before final acceptance of raw water piping system, provide as-built locations of systems and components, showing pressure pipelines, including grade breaks or alignment, horizontal and vertical locations of all utility crossings, finished grade profile on all alignments, and valve locations. The submitted data shall be certified by a Washington licensed land surveyor.

Shop Drawings: Drawings showing pipe diameter, pipe class, and fitting details.

Submittals–Approval Not Required

Information/Record (IR): Hydrostatic test documentation form and results.

Part 2 – Products

Materials

Bell and Spigot Pipe:

PVC, conforming to requirements of AWWA C900.

DR shall be 14, 200-psi pressure class.

Joints:

Rubber gasketed.

Conform to AWWA C900.

Fittings: Ductile iron, conforming to AWWA C153 or C110.

Solvent Weld PVC Pipe and Fittings: As specified on Piping Data Sheet located at the end of this section as a supplement.

Part 3 – Execution

Installation of Schedule 80 Solvent Weld Pipe

In accordance with Section 02500, RAW WATER CONVEYANCE PIPING - GENERAL.

Installation of C900 Bell And Spigot Pipe

In accordance with AWWA C605.

Joints:

Rubber Gasketed: In accordance with manufacturer's written instructions.

Restrained Joint Systems: In accordance with manufacturer's written instructions.

Pipe Bending for Horizontal or Vertical Curves: Radius of curves shall not exceed 75 percent of manufacturer's recommended values.

Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

Maximum Joint Deflection: 75 percent of manufacturer's recommended values.

Construction Quality Control

Cleaning

Following assembly and testing, and prior to final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

If impractical to flush large diameter pipe at 2.5 fps, clean pipe by use of pipe pig as approved by Construction Manager. Multiple passes of pipe pig may be required to adequately clean line.

Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

Pipeline Hydrostatic Test:

General:

Notify Construction Manager in writing at least 5 days in advance of testing. Construction Manager will coordinate with other parties required to witness testing. Perform testing in presence of Construction Manager.

Using water as test medium, all newly installed pipelines shall successfully pass hydrostatic leakage test prior to acceptance.

Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Construction Manager, be done prior to placement of asphaltic concrete or roadway structural section.

Construction General Contractor may, if field conditions permit and as approved by Construction Manager, partially backfill trench, and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.

Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.

Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.

Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

Procedure:

Furnish testing equipment, as approved by Construction Manager, which provides observable and accurate measurements of leakage under specified conditions.

Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.

Expel air from piping system during filling.

Test Pressure: 173 psi as measured at low point of pipeline.

Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure.

Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

Identify method of disposing water after system testing.

Maximum Allowable Leakage:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour.

N = Number of joints in tested line.

D = Nominal diameter of pipe, in inches.

P = Average test pressure during leakage test, in pounds per square inch.

Supplements

Supplement 1—Solvent Weld Polyvinyl Chloride (PVC) Pipe and Fittings.

END OF SECTION 02509

1 **Table 1. Solvent Weld Polyvinyl Chloride (PVC) Pipe and Fittings**

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling.
Bolting	All	ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/ A194M Grade 8M hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Lubricant	All	Teflon tape

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SECTION 02631 – CATCH BASINS SCHED. B

Part 1 – General

References

The following is a list of standards that may be referenced in this section:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M105	Standard Specification for Gray Iron Castings
AASHTO M198	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

ASTM INTERNATIONAL (ASTM)

ASTM A536	Standard Specification for Ductile Iron Castings
ASTM C387	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections

Part 2 – Products

Precast Units

Precast units shall conform to ASTM C478 except dimensions shall be as shown on the Drawings.

The joints shall be the tongue-and-groove type or the shiplap type, sufficiently deep to prevent lateral displacement. Precast concrete units shall be furnished with knockouts or cutouts.

Rubber gaskets for use in joints of precast catch basin sections shall conform to the applicable requirements of AASHTO M198. Rubber gasket material shall be stored in a clean, cool place, protected from sunlight and contaminants. They shall be protected from direct sunlight at all times except during actual installation.

Concrete risers for extensions shall be a maximum of 6 inches high and of same quality as sections. Risers shall be reviewed by Engineer before installation.

Mortar

Standard premixed mortar conforming to ASTM C387, Type S, or proportion 1 part Portland cement to 2 parts clean, well-graded sand which will pass a 1/8-inch screen. Admixtures may be used not exceeding the following percentages of weight of cement: Hydrated lime, 10 percent; diatomaceous earth or other inert materials, 5 percent. Consistency of mortar shall be such that it will readily adhere to concrete.

Rings And Covers

Castings for catch basin rings shall be gray-iron conforming to the requirements of AASHTO M105, Grade 30B. Covers shall be ductile iron conforming to ASTM A536, Grade 80-55-06.

Catch basin rings and covers shall meet the strength requirements of Federal Specification RR-F-621E. All mating surfaces shall be machine finished to ensure a nonrocking fit.

The horizontal surface and inside vertical recess face of the ring, and the horizontal seating surface and vertical outside edge of the cover, shall be machine finished to the following tolerances:

Ring: +3/32 inch to -3/32 inch.

Cover: +3/32 inch to -3/32 inch.

All catch basin rings and covers shall be identified by the name or symbol of the manufacturer and country of casting origin. This identification shall be in a plainly visible location when the ring and cover are installed. Ductile iron shall be identified by the following, “DUC” or “DI”. The manufacturer’s identification and material identification shall be adjacent to each other and shall be minimum 1/2-inch to maximum 1-inch high letters, recessed to be flush with the adjacent surfaces.

Part 3 – Execution

Excavation And Backfill

The excavation for all catch basins shall be sufficient to leave 1 foot in the clear between their outer surfaces and the earth bank. Backfilling of catch basins shall be done in accordance with the provisions of Section 02320 TRENCH BACKFILL. Backfilling around the work will not be allowed until the concrete and mortar have thoroughly set. Any excavation safety systems shall meet the requirements of Section 02316, EXCAVATION.

Placing Precast Units

If material in bottom of trench is unsuitable for supporting unit, excavate and backfill to required grade with 3-inch minus, clean, pit-run material. Set units to grade at locations shown.

Ladder rungs shall be grouted in the precast concrete walls. Rungs shall be uniformly spaced at 12 inches and be vertically aligned.

The ends of all pipes shall be trimmed flush with the inside walls.

Rubber gaskets may be used in tongue-and-groove joints of precast units. All other joints and all openings cut through the walls shall be grouted and watertight.

If gaskets are used, handling of the precast units after the gasket has been affixed shall be done carefully to avoid disturbing or damaging the gasket or contaminating it with foreign material. Care shall be exercised to attain proper alignment before the joints are entirely forced home. During insertion of the tongue or spigot, the units shall be partially supported to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned.

Catch basins shall be watertight.

Extensions

Install extensions to height determined by Engineer. Lay risers in mortar with sides plumb and tops to grade. Joints shall be sealed with mortar, with interior and exterior troweled smooth. Prevent mortar from drying out and cure by applying a curing compound. Extensions shall be watertight.

Installation Of Rings And Covers

Set rings and covers at elevations indicated or as determined in field and in conformance with Drawings.

Rings may be cast in, or shall be set in mortar.

The cover of a catch basin shall not be grouted to final grade until the final elevation of the adjacent ground surface has been established. Covers shall be seated properly to prevent rocking.

Cleaning

Upon completion, clean each structure of all silt, debris, and foreign matter.

END OF SECTION 02631

SECTION 02632 – STORMWATER PIPING SCHED. B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section and any supplemental Data Sheets:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M294	Standard Specifications for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

ASTM INTERNATIONAL (ASTM)

ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

Submittals–Approval Not Required

Information/Record (IR): Catalog and manufacturer's data sheets for stormwater pipe and fittings.

Part 2 – Products

Pipe And Fittings

Pipe and fittings for culverts and stormwater pipes shall be corrugated polyethylene (CPE) in accordance with the following:

Item	Description
Pipe	AASHTO M294
Pipe Stiffness (Minimum)	In accordance with specified AASHTO Specification Profile Type S
Joints	Bell and spigot, gasketed type and water-tight. Gaskets ASTM F477
Fittings	Manufacturer's standard; same stiffness as adjacent pipe.
Source Quality Control	In accordance with specified AASHTO Specification.
Factory Testing	Pipe lengths used for deflection testing shall be destroyed after testing.

Part 3 – Execution

Installation Of Pipe, Fittings, And Appurtenances

General:

Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipeline will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

Prevent entry of foreign material into gasketed joints.

Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

Trench excavation and placement of pipe bedding and pipe zone materials shall be in accordance with Section 02320, TRENCH BACKFILL.

Any excavation safety systems shall be in accordance with Section 02316, EXCAVATION.

Pipe Cleaning:

Prior to final acceptance and final inspection of the stormwater pipes by Construction Manager, flush and clean all stormwater pipes and catch basins. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material. If necessary, use mechanical rodding or bucketing equipment.

Upon Construction Manager's final inspection of the stormwater pipes, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

END OF SECTION 02632

SECTION 02661 – GEOMEMBRANES SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D4218	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5397	Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tension Load Test (Appendix A, Single Point)
ASTM D5596	Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI-GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage
GRI-GM13	Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembrane

Description

The work includes IDF manufacture, fabrication (if needed), supply, and installation of geomembrane for the lining system, and for other geomembrane applications, as shown on the Drawings. Geomembrane is also referred to as flexible membrane liner (FML).

Definitions

CQA Certifying Engineer: Engineer providing independent oversight and responsible for implementing the CQA Plan. Independent is defined as an organization that operates separately from the Construction General Contractor, DOE-ORP, and the Tank Farm Contractor.

Engineer: Design Engineer for the IDF, providing technical design support during construction.

Construction Manager: Construction coordinator overseeing the IDF construction activities in the field and the Tank Farm Contractor's onsite technical representative.

Construction General Contractor: Responsible for overall construction activities and operations, including Construction Subcontractors.

Installer: Construction Subcontractor responsible for installation of geosynthetics (geomembrane, GCL, CDN, and geotextiles).

LCRS: Leachate collection and removal system.

LDS: Leak detection system.

SLDS: Secondary Leak Detection System.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Construction General Contractor shall submit required interface strength data as specified in PART 2-PRODUCTS prior to shipment of material to allow Engineer to evaluate if submitted material meets strength requirements for project design criteria. Allow Engineer 20 working days for this evaluation upon receipt of data.

Installation Plan:

The Construction General Contractor shall submit an installation plan describing the proposed methods for geomembrane deployment, panel layout, seaming, repair, and protection. The installation plan shall provide for no field seam locations within the LCRS sump trough under the leachate collection and riser pipes. Construction General Contractor shall orient panel layout such that one full panel width spans the LCRS sump trough. The plan shall also include a quality control program for the Construction General Contractor's activities related to geomembrane installation.

Manufacturer's Quality Control (QC) test data for geomembrane composition and properties as specified in paragraph MANUFACTURING QUALITY CONTROL - POLYETHYLENE GEOMEMBRANES.

Manufacturer's QC certification as specified herein.

The Construction General Contractor shall submit Geomembrane Installer's organizational and seaming personnel qualifications, and other as required to provide the information described in these Specifications.

The Construction General Contractor shall submit Geomembrane Installer's Certificate of Subgrade Acceptability to the CQA Certifying Engineer as specified herein.

Calibration certification for construction quality control test equipment.

Submittals–Approval Not Required

Information/Record (IR):

Documentation of test results from construction quality control testing.

Construction Quality Assurance (CQA)

CQA Plan: A CQA Plan has been prepared as part of the landfill design. The CQA Plan discusses the testing procedures that will be followed by the CQA Certifying Engineer during installation of the geosynthetics (geotextile, CDN, geomembrane, GCL) and the documentation of the process. The CQA Plan is made part of these Specifications by reference. The Construction General Contractor shall conform to the requirements of the CQA Plan for all aspects of the geosynthetics, including submittals, supply, storage, installation, testing, documentation, covering, and protection.

Quality assurance procedures are presented in the CQA Plan. The Construction General Contractor shall accommodate all quality assurance activities described in this section and in the CQA Plan for this project.

Prior to placing any materials over the installed geomembrane, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA Conformance Testing

Upon delivery of the rolls of geomembrane, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or one per 50,000 square feet of geomembrane, whichever results in greater number of tests. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of guaranteed properties.

As a minimum, tests to determine the following characteristics will be performed on geomembranes:

Thickness (ASTM D5994).

Tensile characteristics (yield strength, elongation at yield; ASTM D638).

Asperity (GM-12).

Puncture resistance (ASTM D4833).

Where optional procedures are noted in the test method, the requirements of these Specifications will prevail.

Sampling Procedures:

Samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Certifying Engineer will mark the machine direction on the samples with an arrow.

The CQA Certifying Engineer shall be allowed to remove samples for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

Warranty

The geomembrane manufacturer(s) shall provide warranties on all geomembrane materials installed at the project site. The warranties shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the geomembrane manufacturer. The terms of the warranties shall, at a minimum, include the provisions contained in the most recent version of GRI Test Method GM-13.

Part 2 – Products

General

Type: High-density polyethylene (HDPE). Unreinforced, 60-mil nominal thickness, textured both sides.

Manufacturer: The HDPE geomembrane manufacturer(s) shall have a minimum of 5 years of experience as a commercial manufacturer of HDPE geomembranes for landfill applications. Examples of potential manufacturers include: GSE Lining Technology, Inc., Houston, TX; and Poly-Flex, Inc., Grand Prairie, TX. Use of these examples is not intended to restrict potential manufacturers.

Required Properties - Polyethylene Geomembranes

Use of Recycled Polymer: The raw material shall be new polyethylene resin containing no more than two percent clean recycled polymer by weight. Two percent-recycled polymer shall not include any finished sheet material that has actually seen some type of service performance. Regrind, reworked, or trim materials in the form of chips or edge strips that have not actually seen some type of use may be added, if the material is from the same manufacturer and is the same formulation as the geomembrane being produced.

Resin Properties: The resin shall meet the following Specifications:

HDPE:

Resin Specific Gravity (ASTM D1505): >0.932.

Melt Index (ASTM D1238 Condition 190/2.16): <1.1 g/10 min.

Finished Sheet Properties: The physical, mechanical, and environmental properties of the finished sheet shall meet or exceed the values specified in Table 1 contained in this part of the Specifications. Where applicable, values in Table 1 are Minimum Average Values.

Required Interface Shear Strength Data:

Provide data prior to material shipment for the interface friction angle between the textured geomembrane and other materials (including CDN, GCL, and Admix Liner) directly in contact with the geomembrane as specified in Article SUBMITTALS. Perform two interface shear strength tests on each interface under each set of normal loads.

Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321 or D6243 for GCL interface) at both low normal loads of 100, 250, and 500 pounds per square foot (psf), and high normal loads of 2,000, 8,000, and 15,000 psf. Report results for both peak and large displacement (minimum 2 inches) strength.

The Engineer will review this data for conformance with project strength requirements. Construction General Contractor shall not order material for shipment until approved by Engineer. Any product or material changes required as a result of inadequate strength data will be addressed by Change Order provided submitted material meet all other requirements of this section.

Manufacturing Quality Control - Polyethylene Geomembranes

Quality Control Testing: Quality control testing shall be carried out by the manufacturer to demonstrate that the geomembrane meets the Specifications in this section. Additional testing may be carried out for purposes of determining conformance by the CQA Certifying Engineer. If the results of the manufacturer's and the CQA Certifying Engineer's testing differ significantly, the testing shall be repeated by the CQA Certifying Engineer, and the manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

Required Information: Prior to the delivery of any geomembrane material, the manufacturer shall submit the following information:

The origin (resin supplier's name, resin production plant), identification (brand name, number), and production date of the resin.

A list of quantities and descriptions of materials other than the base polymer, which comprise the geomembrane.

Copies of the quality control certificates issued by the resin supplier.

Reports on the tests conducted by the manufacturer to confirm that the quality of the resin used to manufacture the geomembrane satisfy these Specifications.

A statement that recycled polymer (if any) is clean and does not exceed 2 percent by weight.

A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in these Specifications, or equivalent.

Reports on the tests, including sampling procedures, conducted by the manufacturer to confirm that the geomembrane meets the Specifications.

A certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer.

QC Certification: Prior to shipment, the geomembrane manufacturer shall provide a quality control certificate for each roll of geomembrane. The quality control certificate shall be signed by a responsible party employed by the geomembrane manufacturer, such as the production manager. The quality control certificate shall include:

Roll numbers and identification, resin lot, and batch numbers.

Sampling procedures and results of quality control tests. As a minimum, results shall be given for thickness, asperity, tensile strength, and tear resistance in accordance with methods indicated in these Specifications. Tests shall be conducted on each production lot of geomembrane or every 50,000 square feet, whichever results in the greater number of tests.

Manufacturing Plant Visit: The manufacturer shall allow the CQA Certifying Engineer or his designated representative to visit the manufacturing plant, if the CQA Certifying Engineer so chooses. If possible, the visit shall be prior to or during the manufacturing of the geomembrane rolls for the specific project. The CQA Certifying Engineer or his designated representative shall review the manufacturing process, quality control, laboratory facilities, and testing procedures. During the visit, visiting personnel will also:

Confirm that the measurements of properties by the manufacturer are properly documented and test methods used are acceptable.

Spot inspect the rolls and confirm that they are free of holes, blisters, or any sign of contamination by foreign matter.

Review packaging and transportation procedures to confirm that these procedures are not damaging the geomembrane.

Confirm that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, and roll number.

If applicable, confirm that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

The geomembrane manufacturer shall accommodate these activities.

Extrudate

Extrudate for Fusion Welding of HDPE Geomembrane: Formulated from same HDPE resin as geomembrane and shall meet applicable physical property requirements.

Field-Fabricated Boots

Pipes and other structures penetrating the lining system shall be sealed to the geomembrane with fabricated boots made of the same material and workmanship as the lining system geomembrane. The flange portion of each boot shall match the angle of the slope or bottom, be sealed to the geomembrane, and fit smoothly without folds or stretching of the material.

Sealant Caulking

Where shown on the Drawings, the caulking used shall be a one-component sealant formulated of butyl rubber and other selected ingredients, equivalent to Biddle Co., St. Louis, MO, Butylgrip Sealant, or as recommended by the manufacturer of the geomembrane materials.

Stainless Steel Clamps

As indicated on the Drawings, clamps shall be used to secure the HDPE geomembrane to pipes, poles, or risers that are intended to protrude through the cover. One-half-inch wide clamps shall meet or exceed specifications for "Make-a-Clamp" as manufactured by Breeze Clamp Products Division, Federal Laboratory, Inc., Saltsburg, PA.

Butyl Mastic Tape

Shall be as manufactured by Tremco, Cleveland, OH; or of a type recommended by HDPE geomembrane manufacturer.

Neoprene Rubber Pad

As indicated on the Drawings, neoprene rubber shall be used as compression strip beneath the stainless steel clamps (ASTM D2240). One-half-inch thick neoprene rubber shall be 35-to 40 durometer hardness, as supplied by Aero Rubber Co., Inc., Bridgeview, IL, or approved equal. Cut to a continuous 2-inch wide piece of neoprene to form the gasket. Neoprene rubber contact cement recommended by the supplier shall be used to bond butt ends of joined strips and to bond neoprene rubber in position on surface. Butt joints in neoprene strips shall be offset from adjacent joints by at least 6 inches.

Tensiometer For Field Testing

Motor driven with jaws capable of traveling at measured rate of 2 inches per minute. Equipped with gauge, which measures force in unit pounds exerted between jaws.

Plywood Sheeting

Use APA rated sheeting EXT for protection of the HDPE geomembrane at termination edges on south side of Phase I.

Part 3 – Execution

General:

Personnel Qualifications - Polyethylene Geomembranes:

Installer Organization: At a minimum, the Construction General Contractor organization shall have successfully completed at least five projects consisting of installation of at least 5,000,000 square feet (total) of HDPE liner. Projects shall include RCRA landfills.

Seaming Personnel: All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests similar to those described in this section. The superintendent and lead welder foreman shall have experience seaming a minimum of 1,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus proposed for use on this project. These individuals shall provide direct supervision over less experienced seamers.

No field seaming shall take place without one of these individuals being present. Key personnel are defined as the superintendent, foreman, and lead welder. Key personnel shall be full time employees of the Geosynthetics Installer.

Applicability: The primary and secondary geomembranes shall be installed at the locations, lines, and grades shown on the Drawings. All geomembranes shall be installed in accordance with these Specifications and the CQA Plan.

Installation Plan: Prior to beginning geomembrane installation, the Construction General Contractor shall submit a plan describing the proposed size, number, position, and sequence of geomembrane panel placement, and location of field seams.

Subgrade Surface Preparation - Polyethylene Geomembranes

The Construction General Contractor shall be responsible for preparing the subgrade surface of the soil bentonite liner for the geomembrane. Prepare the underlying soil surface as specified in Section 02319, SUBGRADE PREPARATION, and as approved by the Geomembrane Installer.

The Geomembrane Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the Installer to the Construction General Contractor prior to commencement of geomembrane installation in the area under consideration. The CQA Certifying Engineer shall be given a copy of this certificate by the Construction General Contractor. The form for Geomembrane Installer certification is provided as Supplement to this Specification. Submittal of this form only applies to soil surfaces underlying the geomembrane. In this case Geomembrane Installer Certification of Subsurface Acceptability is only required for the surface on which the secondary and SLDS geomembrane shall be installed.

After the subgrade surface has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the Construction General Contractor any change in the subgrade surface condition that may require repair work.

Special care shall be taken to avoid desiccation cracking or freezing of the admix liner. Specifications for allowable desiccation cracking of soil liner and repair measures are contained in Section 02666, ADMIX LINER. The surface of the admix liner shall be maintained in the required condition throughout the course of geomembrane installation.

Anchor Trench Excavation and Backfilling

The anchor trench shall be excavated to the lines and widths shown on the design Drawings, prior to geomembrane placement. The corners of the trench shall be rounded so as to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. Backfill with material as shown on the Drawings and compact as specified in Section 02320, TRENCH BACKFILL.

Geomembrane Placement - Polyethylene Geomembranes

Field Panel Identification: A field panel is the unit area of geomembrane, which is to be seamed in the field. Two cases are defined:

If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.

If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It will be the responsibility of the CQA Certifying Engineer to assign each field panel an "identification code" (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Construction Manager, Installer, and CQA Certifying Engineer.

This field panel identification code shall be as simple and logical as possible. (Note that roll numbers assigned in the manufacturing plant are usually cumbersome and are not related to location in the field.)

The CQA Certifying Engineer will establish a table or chart showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for all quality assurance records, including Installer's quality control (QC) testing.

Field Panel Placement:

Location: Field panels shall be installed at the locations indicated in the Installer's layout plan, as approved or modified.

Installation Schedule: In general seaming of geomembrane will be performed the same day as deployment. However, at the discretion of Geosynthetic Installer, seaming may be carried over to the following workday.

Placement Conditions:

Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface unless installation procedures approved by the CQA Certifying Engineer are in place to address environmental conditions. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. Placement methods shall prevent damage to underlying soil liner or geosynthetic materials.

Factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage shall be considered. Textured-surface sheets shall be aligned in a manner, which maximizes their frictional capabilities along the slope. Maneuver sheets of geomembrane into place in a manner, which prevents wrinkles, folds, or similar distress, which can damage the geomembrane or prevent its satisfactory alignment or seaming. A smooth-surface HDPE geomembrane rub sheet shall be used when placing textured HDPE geomembrane over underlying GCL. The rub sheet shall be maintained in good condition without tears, rough edges, holes, or scuff marks that can catch, displace, or otherwise disturb the underlying GCL, or the overlying geomembrane.

Damage: Damaged panels or portions of damaged panels, which have been rejected, shall be removed from the work area. Any repairs shall be made according to procedures described in this Part of the Specifications.

Exposed Geomembrane Protection: After panel deployment, all geomembrane, except those shown as permanently exposed on the Drawings, shall be covered to within a maximum period of 20 working days to minimize exposure to temperature cycles that cause expansion/contraction of the geomembrane and desiccation of the underlying admix liner. Exposure in excess of 15 days, Construction General Contractor will peel back leading panel of geomembrane on a routine basis (established by the CQA inspector) for CQA to inspect for desiccation of admix liner. Any observed desiccation observed outside of specification tolerance will be repaired and the geomembrane covered immediately. Additional exposure areas may be required by CQA to verify complete repair areas required. Geomembrane panels shall be covered by other geosynthetic components of the lining system or overlying soil cover materials as shown on the Drawings.

Field Seaming - Polyethylene Geomembranes

Seaming Equipment and Products: Approved processes for field seaming are extrusion welding and fusion welding, except that use of extrusion welding shall be limited to areas (such as sumps or repairs) where fusion welding cannot be employed. Proposed alternate processes shall be documented and submitted by the Installer to the Construction Manager and CQA Certifying Engineer for approval. Only equipment, which has been specifically approved by make and model, shall be used.

Extrusion Process:

The extrusion-welding machine shall be equipped with gages capable of measuring the temperature at the nozzle or the preheat temperature.

The Installer shall provide documentation regarding the extrudate and shall certify that the extrudate is compatible with these Specifications and is comprised of the same resin type as the geomembrane sheeting.

The Installer shall comply with the following:

The Installer shall maintain on-site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operation.

The equipment used for seaming shall not be likely to damage the geomembrane.

The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel.

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

Grinding shall be completed no more than 1 hour prior to seaming.

A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

Fusion Process: The fusion-welding machines shall be automated vehicular-mounted devices. The fusion-welding machines shall be equipped with gages giving the pertinent temperatures.

The Installer shall comply with the following:

The Installer shall maintain on site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operations.

The equipment used for seaming shall not be likely to damage the geomembrane.

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

If a build-up of moisture is observed prior to seaming a movable protective layer shall be used directly below each overlap of geomembrane to be seamed to prevent buildup of moisture between the sheets.

Seam Layout: In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope to the maximum extent practical. In corners and odd-shaped geometric locations, the number of seams shall be minimized. No seams shall be permitted within the LCRS sump trough for leachate collection and riser pipes. One full panel width shall span the LCRS sump trough.

On the landfill floor:

No horizontal seam shall be less than 5 feet from the toe of the slope, or other area of potential stress concentrations.

Over the LCRS, LDS, and SLDS sump areas in each cell, no horizontal seam shall be placed less than 150 feet from the toe of the north slope for a distance of at least 100 feet in each direction from the LCRS and LDS sump centerline.

Seams shall be aligned to produce the fewest possible number of wrinkles and "fishmouths".

A seam numbering system consistent with the panel numbering system shall be utilized.

Weather Conditions for Seaming: The allowable weather conditions for seaming are as follows:

Unless authorized in writing by the Construction Manager, no seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface.

The geomembrane shall be dry, protected from wind, and free of dust.

If the Installer wishes to use methods, which may allow seaming at ambient temperatures below 32 degrees F, the Installer shall certify in writing that the quality of the seams welded at these temperatures is the same as the quality of seams welded at temperatures above 32 degrees F. In addition, if the Installer wishes to seam at ambient temperatures below 32 degrees F, the following conditions shall be satisfied in addition to the general seaming procedures:

For extrusion welding, preheating shall be performed. Preheating may be waived by the Construction Manager if it is demonstrated to the satisfaction of the CQA Certifying Engineer that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

Sheet grinding, if required, may be performed before preheating.

Observe all areas of the geomembrane that have been preheated to determine that they have not been subjected to excessive melting.

Confirm that geomembrane surface temperatures have not decreased below the minimum specified for welding, due to wind or other adverse conditions. Wind protection for the seam area may be required.

Trial seams, as described in paragraph Trial Seams of this section, shall be made in the immediate area where seaming will occur, under the same ambient temperature and preheating conditions as the actual seams. New trial seams shall be made if the ambient temperature decreases by more than 5 degrees F from the previous trial seam conditions. Such new trial seams shall be conducted as soon as seams in progress during the temperature drop have been completed.

Additional destructive seam tests, as described in paragraph Destructive Seam Strength Testing of this section, shall be performed at intervals of 250 to 500 feet of seam length at the CQA Certifying Engineer's discretion.

The Installer shall provide sample coupons cut from each end of the seam.

Seam Preparation:

Cleaning: Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. Special attention shall be paid to cleaning the existing geomembrane at tie-in locations.

Overlap: Cross slope, seams on both the trench floor and sideslopes shall be overlapped so that liquids are not trapped, i.e., seams shall be shingled downslope. If seam overlap grinding is required, the process shall be completed according to the geomembrane manufacturer's instructions within 1 hour of the seaming operation, and in a way, that does not damage the geomembrane. Panels of geomembrane shall have a finished overlap of a minimum of 3 inches for extrusion welding and 5 inches for fusion welding.

Use of Solvents: No solvent or adhesive shall be used.

Temporary Bonding: The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

General Seaming Procedure: The general seaming procedure used by the Installer shall be as follows:

Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

If seaming operations are carried out at night, adequate illumination shall be provided.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed, and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

Construction Quality Control Testing - Polyethylene Geomembranes

General: Testing requirements specified herein are intended for the Construction General Contractor (and Geomembrane Installer) during geomembrane installation. Testing requirements for the CQA Certifying Engineer are provided in the CQA Plan.

Trial Seams:

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. A trial seam shall be made prior to each seaming period (maximum of 6 hours) for each seaming machine used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 2 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in this Part.

Test three specimens for peel and two specimens for shear. Each specimen shall be at least 1 inch wide and shall be cut from the trial seam sample by the Installer. The specimens shall be tested respectively in shear and peel using a field tensiometer, and they shall not fail in the seam. All trial seam specimens must meet the minimum requirements of Table 2, Required Seam Properties, for trial seam acceptance. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall provide the Construction Manager and CQA Certifying Engineer with current calibration certificates.

Nondestructive Seam Continuity Testing:

General:

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method (i.e., spark test). Vacuum testing and air pressure testing are described below. The purpose of the nondestructive test is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be done as the seaming work progresses. Nondestructive testing will not be permitted before sunrise or after sunset unless the Construction General Contractor demonstrates to the CQA Certifying Engineer their capability to perform testing under reduced light conditions. Any seams, which fail nondestructive testing, shall be repaired in accordance with these Specifications. Seams, which cannot be nondestructively tested because of seam geometry, shall be double welded or capped.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

Vacuum Testing: The equipment shall be comprised of the following:

A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gage.

A steel vacuum tank and pump assembly equipped with a pressure controller and connections.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and wide paint brush.

A soapy solution.

The following procedures shall be used:

Energize the vacuum pump and reduce the tank pressure to a minimum of 5 inches of mercury.

Wet a strip of geomembrane approximately 12 inches wide by 48 inches long with the soapy solution.

Place the vacuum box over the test area.

Close the bleed valve and open the vacuum valve.

Ensure that a leak tight seal is created.

For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear coming from the seam after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.

All areas where soap bubbles appear shall be marked and repaired in accordance with this Part.

Air Pressure Testing: The following procedures are applicable only to those processes, which produce a double seam with an enclosed air channel. All double seams with an enclosed air channel shall be air pressure tested. The equipment shall be comprised of the following:

An air pump (manual or motor driven) capable of generating and sustaining a pressure of 60 to 65 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device.

A calibrated pressure gage capable of reading pressures up to 65 psi.

The following procedures shall be used:

Seal both ends of the seam to be tested.

Insert needle with pressure gage, or other approved pressure feed device, into the air channel created by the fusion weld.

Energize the air pump and pressurize the channel to a minimum 25 psi for a 1/2-inch wide channel, or 55 psi for a 1-inch wide channel. Close the valve and sustain the pressure for a minimum of 5 minutes.

If loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with this section. If significant changes in geomembrane temperature occur during the test (e.g., due to cloud cover), the test shall be repeated after the geomembrane temperature has stabilized.

Cut end of seam opposite to the pressure gage and observe that the pressure drops. If the pressure does not drop, locate the obstruction(s) in the seam, repair, and retest seam.

Remove needle or other approved pressure feed device and repair seam.

Destructive Seam Strength Testing:

General:

Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses. The samples shall meet the requirements of Table 2, Required Seam Properties.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

Each sample shall be tested for bonded seam shear and peel strength by an independent testing laboratory.

Test at least five specimens for each seam test method (shear and peel). Four out of five specimens must meet the minimum requirements of Table 2, Required Seam Properties, for field seam acceptance.

Location and Frequency:

Destructive seam samples shall be obtained from actual fabricated field seams as work progresses, not at the completion of field seaming. The CQA Certifying Engineer will select locations where seam samples will be removed.

Sampling frequency shall be a minimum of one sample per 500 feet of seam length per welding machine (this minimum frequency shall be determined as an average taken from all the panels, including welds for caps), or a minimum of two samples per factory panel, whichever gives the largest number of samples. If agreed by all parties (Construction General Contractor, Construction Manager, and the CQA Certifying Engineer) the frequency of destructive seam testing may be reduced to one sample per 1,000 feet of seam if test results and other nondestructive seam tests appear adequate for assuring seam quality. If, based on the specified test frequency, a destructive test location should fall within the LCRS or LDS sump area (as shown on the Drawings); the distance between destructive tests shall be reduced to relocate the destructive test location outside the sump area.

Sampling Procedures:

Samples shall be cut by the Installer as the seaming progresses in order to provide laboratory test results before completion of installation. The CQA Certifying Engineer shall assign a number to each sample, mark it accordingly, and record the sample location on the layout drawing.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures. The continuity of the new seams in the repaired area shall be tested as described in this Part.

Sample Size: The samples shall be minimum 12 inches wide by minimum 42 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the samples, and these shall be tested in the field as described below. The remaining sample shall be distributed as follows:

One portion (minimum 12 inches by 12 inches) to the Installer for laboratory testing at his discretion.

One portion (minimum 12 inches by 12 inches) to the Construction Manager for archive storage.

One portion (minimum 12 inches by 18 inches) to the CQA Certifying Engineer for laboratory testing.

Field Testing:

The two 1-inch wide strips described above shall be tested in the field by tensiometer for peel and shear and shall not fail in the seam. If any test sample fails to pass, then the procedures outlined below (Procedures for Areas Failing Destructive Tests) shall be followed.

The CQA Certifying Engineer will mark all samples and portions with its number. The CQA Certifying Engineer will also record the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail descriptions, and attach a copy to each sample portion.

Procedures for Areas Failing Destructive Tests: The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the independent testing laboratory, the Installer's laboratory, or by field tensiometer. The Installer has two options:

The Installer shall cap the seam between any two passing test locations, or

The Installer shall trace the seam to two intermediate locations 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full samples shall be taken for laboratory testing.

If these laboratory samples pass the tests, then the seam shall be capped between these locations. If either sample fails, then the sampling and testing process shall be repeated to establish the zone over which the seam shall be capped.

All acceptable capped seams shall be bounded by two locations from which samples passing CQA laboratory destructive tests have been taken. In cases where the length of the capped seam exceeds 150 feet, a sample of the capping seam shall be taken and shall pass destructive testing as described in this Part.

Repairs - Polyethylene Geomembranes

General:

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. All repairs shall be conducted in accordance with this Part. All repairs shall be subjected to the nondestructive seam testing procedures described in this Part.

Each patch or other type of repair will be numbered and recorded.

Repair Procedures:

Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

Grinding and rewelding, used to repair small sections (typically with a maximum length of no more than several inches) of extruded seams.

Spot welding or seaming used to repair pinholes.

Capping, used to repair large lengths of failed seams or areas where large wrinkles or fish mouths have been cut to flatten the geomembrane sheet.

Topping, used to repair areas of inadequate seams, which have an exposed edge. Topping shall be limited to an aggregate length of no more than 3 m (10 feet) on any given seam.

Removing bad seam and replacing with a strip of new material welded into place, used with large lengths of fusion seams.

For all repair methods, the following provisions shall be satisfied as applicable:

Surfaces of the geomembrane, which are to be repaired, shall be abraded no more than one hour prior to the repair.

All surfaces shall be clean and dry at the time of the repair.

Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

Verification of Repairs: Each repair shall be numbered and recorded. Each repair shall be nondestructively tested using the methods described in this Part. Large caps may be of sufficient extent to require destructive test sampling. Repairs that fail nondestructive or destructive tests shall be redone and retested until a passing test is obtained.

Protection Of Termination Edges

Along the south termination of the geomembrane, and along any termination edges of the membrane that may be exposed or buried for extended periods of time prior to their joining to adjacent subsequent sections, the Construction General Contractor shall protect leading edges with protective (sacrificial) layers of cushion geotextile and plywood sheet as shown on the Drawings.

Materials In Contact With Geomembrane

The requirements of this Part are intended only to assure that the installation of other materials does not damage the geomembrane. Additional requirements as established in other sections of these Specifications are necessary to assure that systems built with these other materials are constructed in such a way as to provide proper performance. Material requirements for operations layer and drain gravel are specified in Section 02315, FILL AND BACKFILL.

Requirements of this Part apply to geomembranes that are directly in contact with overlying soil or are covered with a layer of geotextile or geocomposite.

Do not place granular materials in manner that will cause wrinkles to fold over or become confined to form a vertical ridge. Maximum wrinkle height shall be 4 inches and spacing between wrinkles shall be greater than 10 feet prior to placement of granular materials over the geomembrane.

Minimum Thickness: Equipment used for spreading granular material shall not be driven directly on the geomembrane. A minimum thickness of 1 foot of granular material shall be maintained between spreading equipment and the geomembrane. A minimum thickness of 3 feet of granular material shall be maintained between rubber-tired hauling vehicles and the geomembrane. Construction haul vehicles shall have a maximum ground contact pressure of 25 psi.

Spreading Equipment: Equipment used for spreading granular material shall be a light low ground pressure dozer (such as a wide-pad Caterpillar D6M LGP or lighter), low ground pressure excavator (Bucyrus-Erie 325H with 0.91-m [36-in] wide treads or lighter), or approved equal, with a maximum ground contact pressure of 5 psi.

Spreading Operations:

Spreading equipment operating on soil materials shall not spin their tracks, make sharp turns, or make sharp, rapid starts or stops. Soil materials shall be pushed carefully from previously placed material and not dumped directly onto geosynthetics except for the drain gravel in the LDS sump and operations layer material in SLDS sump. This material shall be carefully dumped onto the cushion geotextile or SLDS CDN from a maximum height of 24 inches.

The spreading operation on the sideslope (3H:1V) shall begin at the lower elevations and shall proceed either upslope or laterally at about the same elevation such that a full layer of granular material is always covering the geomembrane downslope from the area being covered. In no case shall the lift thickness be less than the stated minimum. Material shall be placed in such a manner that no air is trapped underneath the geomembrane. Provide and maintain a means of continuously observing the depth of granular materials such as by freestanding markers until placement is complete, at intervals of 50 feet maximum each way. Sharpened stakes or methods that could damage the geomembrane will not be allowed.

Lining System Acceptance - Polyethylene Geomembranes

The Installer shall retain all ownership of and responsibility for the geosynthetics in the lining system until acceptance by the Construction Manager.

The geosynthetic lining system will be accepted by the Construction Manager when all of the following requirements have been satisfied:

The installation is finished.

Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

A written construction report, including “as built” drawings and all other installation documents, has been prepared by the CQA Certifying Engineer, sealed by a registered professional engineer, and received by the Construction Manager.

Supplements

The supplements listed below, following "END OF SECTION”, are a part of this Specification.

Table 1. Required Geomembrane Properties, 60-mil Textured HDPE.

Table 2. Required Seam Properties.

Geomembrane Installer's Certification of Subsurface Acceptability.

END OF SECTION 02661

Table 1. Required Geomembrane Properties 60-Mil Textured HDPE

Specified Property	Qualifier	Unit	Value	Test Method
Physical Properties				
Thickness	min. avg. value	mils	60	ASTM D5994
	minimum		54	ASTM D5994
Specific Gravity	minimum	`N/A	0.932	ASTM D1505
Melt Index	range	g/10 min	<1.1	ASTM D1238 condition 190/2.16
Asperity	min avg. value[1]	mils	10	GRI-GM12
Mechanical Properties				
Tensile Properties	(each direction)		(Type IV)	ASTM D638
Strength at yield	min. avg. value	lb/in	120	
Elongation at yield[2]	min. avg. value	%		12
Tear Resistance	min. avg. value	lb	42	ASTM D1004
Puncture Resistance	min. avg. value	lb	80	ASTM D4833
Carbon Black Content	Range	%	2-3	ASTM D1603 or D4218
Carbon Black Dispersion	Minimum[i] 8 of 10	category	1 or 2	ASTM D5596
Environmental Stress				
Crack	minimum[3]	hrs	200	ASTM D5397

[1] Of 10 readings, 8 out of 10 must be greater or equal to 7 mils, and lowest individual reading must be greater or equal to 5 mils. Provide data for both sides of textured geomembrane.

[2] Yield elongation is calculated using a gauge length of 1.3 inches.

[3] Minimum = mean minus 3 standard deviations from documented manufacturer's quality control (MQC) testing.

Table 2. Required Seam Properties Hdpe Geomembranes

Property	Qualifier	Unit	Specified Value	Test Method
Shear Strength[1]	minimum	lb/in width	90% of tensile strength at yield as listed in tables in this section	ASTM D6392
Peel Adhesion	minimum	lb/in width	60% of tensile strength at yield as listed in tables in this section and FTB[2]	ASTM D6392

[1]Also called "Bonded Seam Strength".

[2]FTB = Film Tear Bond (failure occurs through intact geomembrane, not through seam).

Geomembrane Installer's Certification of Subsurface Acceptability

The geomembrane installer, ____ for the Integrated Disposal Facility (IDF), hereby certifies that the supporting prepared subgrade surfaces are acceptable for installation of the HDPE geomembrane lining system, the undersigned having personally inspected the condition of the constructed surfaces. This certification is for the areas shown on Attachment or defined as follows:

____

____

____

____

The condition of the supporting surfaces in the defined area meets or exceeds the minimum requirements for installation of the geomembrane.

Signed:___________________________________	Signed:________________________________
Geomembrane Installer	Construction General Contractor
Date Signed______________________________	Date Signed____________________________

SECTION 02666-ADMIX LINER SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft^3) (600 Kn-m/m^3)
ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D2216	Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D6391	Standard Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

Description

This section describes the low permeability admix that will be used in the liner of the disposal facility. In addition requirements for base soil in the lining system are specified.

The admix liner is an admixture that consists of natural base soil which is mixed with bentonite and moisture conditioned.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

The Construction General Contractor shall submit a detailed plan for preparation of the admix material, including a description of the equipment and procedures to be used, personnel qualifications, and methods for monitoring bentonite additions and moisture conditioning. This plan shall be approved by the Engineer prior to the start of admix production.

The Construction General Contractor shall submit an admix liner placement plan to specify lift thickness control and to allow for required testing, specified herein and described in the CQA Plan, on the soil liner during placement operations. This plan shall be approved by the Engineer prior to the start of admix placement.

Supplier's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the bentonite proposed for use in the admix complies with the requirements of these Specifications. The manufacturer shall certify that the bentonite furnished complies with these Specifications. A certificate shall be submitted to the CQA Certifying Engineer for each railcar or every three truckloads of bentonite delivered.

Certificates for equipment calibration.

Construction Quality Assurance

Construction Quality Assurance testing will be provided by the CQA Certifying Engineer and shall be performed in accordance with the CQA Plan. The Construction General Contractor shall make allowances for sampling and testing by the CQA Certifying Engineer in both his production operations and schedule.

Prior to placing any materials over the completed admix liner, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan. The Construction General Contractor shall accommodate all CQA testing and sampling activities, as specified in the CQA Plan (i.e., in addition to the QC testing), and shall repair sample locations as specified herein.

Definitions

Grain Size: Determined by ASTM D422.

Imported Material: Meets requirements of this Specification and is obtained offsite and transported to site.

Natural Moisture Content: Determined by ASTM D2216.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Admix: Natural material (base soil), as specified in this section, that when mixed with bentonite.

Admix Liner: Compacted liner component consisting of admix materials, designed, formulated, and constructed to provide low-permeability barrier against infiltration of liquids or contaminants.

Tolerances

Thickness of the admix liner shall be a minimum of 3 feet and tolerances for the top of admix grade shown on Phase I Primary Liner Plan shall be minus 0.1 foot to plus 0.3 foot. The top surface of the admix liner along the north-south centerline of each cell shall be graded to provide a minimum slope of 1.0% for the LCRS collection pipe installation. The minimum required thickness of the soil liner layer shall be maintained. The as-built elevations of the underlying prepared subgrade shall be used as the basis for determining the final elevation of the soil liner layer.

Part 2 – Products

Bentonite

The bentonite shall be Bara-Kade 90, manufactured by Bentonite Performance Materials, Inc.; or approved equal. Do not provide calcium bentonites or chemically treated sodium bentonites.

The bentonite to be used in the admix shall consist of a commercially prepared material and shall have the following index properties:

High Swelling: Ability of 2 grams of base bentonite, when mechanically reduced to minus 100 mesh, to swell in water to an apparent volume of 20 cubic centimeters or more when added gradually to 100 cubic centimeters of distilled water contained in graduated cylinder.

Dry Fineness:

65 percent minimum passing No. 200 U.S. Sieve.

The Construction General Contractor shall provide suitable containers on site to store bentonite in a dry condition prior to use.

Base Soil

The base soil for the admix liner shall consist of natural soil derived from the admix base soil borrow area shown on the Drawings, as specified in Section 02317, BORROW AREA EXCAVATION, or from site excavations. Base soil from either source shall not be excavated below a depth of 5 feet below ground surface (after stripping) without evaluation of the material suitability and approval from the Engineer. This material may be temporarily stockpiled at the stockpile area as shown on the Drawings, or within processing area within Phase I as approved by the Construction Manager.

Base soil excavated from dune sand borrows area or site excavation shall meet the following requirements: The base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious material. Rocks greater than 1 inch in dimension shall not comprise more than 2 percent by weight of the base soil. Base soil shall have 20 percent minimum passing No. 200 U.S. Sieve. Base soil shall be screened or otherwise processed if necessary to meet this requirement.

For evaluating compliance with these requirements, test results shall be considered acceptable when the average value of the data satisfies the associated criterion. Testing and sampling frequency for base soil compliance is provided in the CQA Plan.

Admix Liner Material (Admix)

Composition: The admix shall consist of the base soil mixed with a nominal bentonite content of 12 percent by dry weight of base soil by dry weight. The acceptable range for bentonite content shall be a minimum of 11 percent and maximum of 14 percent of base soil by dry weight. The bentonite percentage and moisture content range may change as a result of preconstruction testing performed on the test pad as described in the CQA Plan, and may be modified by the Construction General Contractor with the approval of the Construction Manager, Engineer, and the CQA Certifying Engineer at any time during the admix processing to reflect changes in the base soil or other components. The moisture content and bentonite dispersion in the admix shall be uniform and homogenous. The finished admix shall be a uniform homogenous material.

CQA Testing: The admix shall be prepared by the Construction General Contractor and tested by the CQA Certifying Engineer in accordance with the CQA Plan. The Construction General Contractor shall make the admix stockpiles available to the CQA Certifying Engineer at all times for sampling, testing, or visual observation.

Raw Water Supply: See Section 02200, SITE PREPARATION, and the Drawings for information on raw water supply availability and requirements for admix processing and admix liner placement and compaction.

Part 3 – Execution

Admix Processing

Bentonite Use Monitoring: Record weight of bentonite used and volume of admix produced each day.

Processing Using Pugmill:

The Construction General Contractor shall process and condition admix material using a central type pugmill plant prior to compaction. The pugmill shall have automated controls to continuously control the established proportions of bentonite and water as ratios of the base soil. It shall have provisions to easily change the proportions. It shall be capable of maintaining a constant time of mixing and varying the rate of discharge so that the degree of mixing can be controlled if necessary to achieve complete mixing.

The Construction General Contractor shall provide all necessary equipment and labor to operate the pugmill, load material into pugmill, offload admix, and stockpile admix.

Equipment: Admix shall be prepared using a pugmill with the following characteristics and ancillary equipment:

Continuous mixing pugmill. Blades shall be adjustable for angular position on shafts and shall be reversible to retard flow of mix.

Belt scales on base soil, bentonite, and finished product belts.

Feed rate meters and totalizers for bentonite, base soil, and water.

Production rate meters and totalizers for finished product.

Variable speed hydraulic supply water pumps capable of producing 500 tons per hour of admixture.

Calibration:

After setting up the pugmill, it shall be calibrated to determine the accuracy of the feed rate for each material being mixed. When the feed controls are set at any desired rate, the measured accuracy shall be within 1 percent by weight of the indicated feed rate for the item being mixed.

The accuracy will be determined by operating each feed control separately and collecting and weighing the material over a given period of time as determined by the CQA Certifying Engineer. The material shall be collected in a dump truck (or appropriate container) supplied by the Construction General Contractor, and the truck will be weighed by the Construction General Contractor and verified by the CQA Certifying Engineer before and after loading. During admix production; the CQA Certifying Engineer may request a recalibration of the feed rate for each material as described above.

All measuring equipment shall be calibrated and calibration certificates provided to the CQA Certifying Engineer prior to starting admix production.

Preparation Requirements:

The base soil shall be processed through a pugmill to add bentonite at the specified rate, to add additional water if required, and to provide mechanical mixing action required to homogeneously blend the bentonite and water into the mix. Additional mixing by rotovator or other approved means shall be performed at the Construction General Contractor's sole expense as required to further break down the soil clumps or if additional mixing is needed to achieve a homogenous blend of soil, water, and bentonite. The admix shall be broken down in size sufficiently to result in at least 80 percent of the soil clumps broken down to 1/2 inch in maximum size. Clods are defined as dry hard particles in the admix that cannot be remolded by hand pressure.

If mixing is found to be insufficient to produce a thoroughly blended, uniform mixture of base soil and bentonite, or the base soil and bentonite are not being mixed in the specified proportions, the Construction General Contractor shall stop production of admix material. The Construction General Contractor shall not restart production and installation of admix liner until procedures and equipment have been modified so that the specified material is produced. Admix liner that is installed without complete mixing or the correct percentage of bentonite shall be removed and modified by the Construction General Contractor to meet the Specifications. After being modified to meet the Specifications, the material may be reinstalled in the lining. Additional work and delays caused by inadequate or incorrect mixing shall be performed at the Construction General Contractor's sole expense. The Construction General Contractor shall not change the bentonite application rate unless directed to do so by the Engineer in writing.

Admix shall be processed and allowed to cure at least 12 hours prior to placement. The Construction General Contractor shall be responsible for maintaining the moisture content of the admix within the specified limits. Admix that does not meet Specifications shall not be reused as feed stock unless approved by the Engineer and CQA Certifying Engineer.

Test Pad(s)

Test pads for the admix liner shall be constructed as specified in Article ADMIX LINER PLACEMENT AND COMPACTION, by the Construction General Contractor to determine acceptable placement and compaction methods to produce a low-permeability admix liner that satisfies the requirements of this section. Both a horizontal and sideslope test pad shall be constructed. The location of the test pads will be designated by the Construction Manager and the CQA Certifying Engineer.

Test Pad Material: The Construction General Contractor will prepare a sufficient quantity of soil for the test pad in accordance with the requirements of Article ADMIX LINER MATERIAL. All specified procedures for mixing, conditioning, and stockpiling of the soil material will be followed.

Horizontal Test Pad Construction:

The test pad will be constructed on a horizontal surface within the limits of the IDF in an area representative of conditions beneath the waste disposal cells. The pad will be located in a well-drained area to prevent surface water intrusion or saturation of the test pad soils.

The test pad location will be cleared and grubbed, and the subgrade will be compacted in the same manner anticipated for construction beneath the waste disposal cells. Prior to placement of the test pad materials, the Contractor's Site Superintendent and the CQA Certifying Engineer will evaluate the condition of the subgrade; areas containing potentially unsuitable materials will be replaced, or another location will be selected for the test pad.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the construction compactor drum width to be used for the full-scale facility and allow for installation of field permeability testing per method ASTM D6391 or 50 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into “lanes” to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the construction compactor drum equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article ADMIX PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

The test pad constructed will include the removal and replacement of a portion of the soil to evaluate the method proposed for repairing defective portions of the full-scale liner as specified in Article REPAIR OF ADMIX LINER.

Sideslope Test Pad Construction:

The sideslope test pad will be constructed on a 3H:1V sideslope (within the lined area of Phase I) to evaluate compaction methods and performance on the sideslope. Field permeability testing is not required for sideslope test pad. Sideslope test pad will be used to demonstrate that compaction and placement methods to achieve acceptable moisture and density requirements can be achieved.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the widest piece of construction equipment to be used for the full-scale facility or 40 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into “lanes” to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the widest piece of construction equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article SOIL BENTONITE PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

Demonstrate the Following During Test Pad(s) Construction:

Base soil/bentonite mixing process prior to compaction.

Compaction equipment type, configuration, and weight.

The method used to break down clods before compaction and maximum resulting clod size.

The speed of compaction equipment traveling over the test pad.

Moisture content of soil bentonite at time of compaction.

Lift thicknesses (compacted), compaction procedures, and number of passes for proposed compaction equipment.

Dry unit weight achieved and measured by field density testing.

Hydraulic conductivity of compacted test fill on undisturbed samples (Shelby Tubes) as described in the Construction Quality Assurance (CQA) Plan.

Field permeability of compacted test fill using ASTM D6391 (horizontal test pad only) as described in the CQA Plan.

Excavate at least four holes, each 3 feet square, through each completed pad for observation, sampling, and testing of compacted material. These holes shall be used for the purpose of demonstrating repair methods as specified herein.

No admix liner shall be placed until the associated test pad has been constructed and the results from all test methods indicate that the admix liner will satisfy the permeability requirements specified in this section. Testing for each test pad shall be as described in the CQA Plan. At the completion of the test pad(s), the CQA Certifying Engineer, as described in the CQA Plan, will prepare an interim report with recommendations for compaction and placement methods to be applied to the full-scale admix liner construction.

After all testing has been completed and approved, the material in the test pad can be used by the Construction General Contractor for liner construction provided that the material satisfies the requirements of these Specifications.

Subgrade Preparation

As specified in Section 02319, SUBGRADE PREPARATION, Article PREPARED SUBGRADE FOR ADMIX LINER.

Admix Liner Placement and Compaction

Lift Thickness: Admix liner material, as specified in Article ADMIX LINER MATERIAL, shall be placed in loose lifts, and compacted such that the compacted lift thickness is 6 inches or less (within a tolerance of 0.1 foot). However, the first lift of admix liner placed over subgrade soils may be placed and compacted to a maximum thickness of 8 inches (within a tolerance of 0.1 foot).

Placement methods shall prevent excessive mixing of admix liner with subgrade soil.

Compaction: The intent of this Specification is that admix liner shall be produced to meet an in-place performance specification of less than 1×10^{-7} cm/sec hydraulic conductivity within the limits of edge of liner shown on the Drawings. See paragraph Outside Edge of Liner in this Article for compaction and hydraulic conductivity requirements beyond edge of liner. The Construction General Contractor is responsible to develop and use compaction methods that produce the required relative compaction.

The moisture-density ranges of the compacted admix shall lie within a trapezoidal-shaped field with the following corners:

Moisture Content (%)	Dry Density (pcf)
8	126

12	110
14	126
19	110

Hydraulic Conductivity: The in-place compacted admix liner shall achieve a saturated hydraulic conductivity as listed below:

All field (in-situ) test results shall be 1 x 10^{-7} cm/sec or less. Field (in-situ) hydraulic conductivity tests will be performed only on admix liner of the horizontal test pad.

All hydraulic conductivity during admix production placement will be verified on undisturbed Shelby tube samples (see ASTM D1587) obtained from in-place admix liner per the CQA plan and then tested in laboratory using methods as described in ASTM D5084.

Hydraulic conductivity will be verified on undisturbed samples from completed areas of the liner as described in the CQA Plan. The arithmetic average of laboratory test results on undisturbed Shelby tube samples shall be less than or equal to 5 x 10^{-8} cm/sec, with no individual test result exceeding 1 x 10^{-7}cm/sec. The acceptable values for laboratory test results will be verified or adjusted prior to admix liner production placement based on the correlation of field and laboratory hydraulic conductivity test results from the horizontal test pad. The final laboratory hydraulic conductivity requirement will be approved by the CQA Certifying Engineer and documented in the horizontal test pad report.

Outside Edge of Liner: Compact admix liner as specified herein. Performance specification for admix hydraulic conductivity do not apply to admix placed beyond edge of liner.

Uniformity: The compacted soil distribution and gradation throughout the liner shall be free from lenses, pockets, streaks, layers, or material differing substantially in texture, moisture content, dry density, or gradation from surrounding material. The admix liner material shall be free of organic debris, frozen material, rubbish, construction debris, and other deleterious material. Any soil containing unacceptable material shall be removed and discarded in the permanent stockpile, placed in accordance with Section 02315, FILL AND BACKFILL.

Moisture Conditioning:

The moisture content of the admix liner shall be uniform throughout each lift prior to and during compaction of the material. If the moisture content of a lift of compacted admix liner falls below the acceptable limit during placement operations, the Construction General Contractor shall moisture condition the dry soil and re-compact the lift prior to placement of additional lifts. If the moisture content of a lift of compacted soil exceeds the acceptable limit due to precipitation or over watering, the Construction General Contractor, before placement of additional lifts, shall either allow the wet soil to dry back or remove the wet soil. If the admix liner material cannot be conditioned to meet the placement specifications, the material shall be removed and replaced with new admix liner.

When the final lift of admix liner placement will be interrupted for more than a few hours or when precipitation is imminent, as determined by the Contractor's Site Superintendent, the lift surface shall be sealed with a smooth drum roller to prevent excessive moisture infiltration. This surface shall be scarified with a rotovator, or other equivalent equipment, immediately prior to resuming soil placement. The Construction General Contractor shall verify that existing moisture content is within the range specified in Article ADMIX LINER PLACEMENT AND COMPACTION, prior to resumption of soil placement activities.

Placement Equipment: The Construction General Contractor shall place layers of the admix liner to form a continuous monolithic material. All admix liner shall be placed and compacted with a self-propelled pegfoot or padfoot roller compactor having a minimum operating weight of 68,000 pounds. Smaller compaction equipment may be used in limited areas as necessary provided that the required moisture/density, lift bonding, and hydraulic conductivity can be achieved. Hydraulic conductivity performance specification for the admix liner will be verified in areas where the lighter equipment is used. Hauling and spreading equipment will not be considered as compaction equipment. The compactor feet shall be sufficiently long to knead (bond) new lifts into previously placed lifts.

The feet shall be kept free of large amounts of dried soil that might restrict foot penetration or become incorporated into the soil lift. The top of each lift may be scarified with a rotovator, or other equivalent equipment or procedures, prior to placing the subsequent lift. The final lift of admix liner may be compacted with a smooth drum roller provided that all other requirements are met.

Provide a smooth soil surface on the final lift prior to placement of the HDPE geomembrane as specified in Article SURFACE FINISHING.

Tie-in Areas: Where new admix liner is tied in to existing admix of a previous day's placement, any areas of the existing admix which are soft, cracked, or otherwise unsuitable shall be removed until acceptable material is exposed. Where new admix will be placed, the surface of the existing admix liner shall be scarified and moisture conditioned as described in this section. New admix liner shall be placed in accordance with the requirements of this section and shall be thoroughly kneaded into the existing admix liner to form a monolithic mass free of seams or other discontinuities.

Placement Method: Admix liner may be placed on the sideslopes in either horizontal lifts (along the contour) or in lifts parallel to the slope (up and down the slope). If admix liner is placed parallel to the slope, compaction equipment shall not spin their wheels or in any other way disturb the previously placed lifts. If this occurs, the Construction General Contractor shall place all of the admix liner in horizontal lifts.

Restrictions: Production, mixing, and stockpiling of admix or native clay soil shall be restricted to the area shown on the Drawings or within the Phase I footprint as approved by the Construction Manager.

Surface Finishing

The surface of the admix liner shall be trimmed to the design grades and tolerances as shown on the Drawings. The surface of the admix liner shall be rolled with a smooth-drum roller to remove all ridges and surface irregularities as specified in Section 02319, SUBGRADE PREPARATION. All wheel ruts in excess of depths specified in Section 02319, SUBGRADE PREPARATION, on the surface of the admix liner shall be repaired by the Construction General Contractor prior to placement of the geomembrane. Acceptable methods for repair of the admix liner are specified in Article REPAIR OF ADMIX LINER.

Maintenance

The Construction General Contractor shall maintain the admix liner surface in a condition suitable for geomembrane installation until the surface is covered. The admix liner shall be protected from desiccation or excessive moisture. This may be accomplished by periodic watering, exclusion of traffic, placement of a temporary removable plastic cover, or other methods. Desiccation cracks larger than 1 inch deep or 0.25 inch wide shall be excavated to the full depth of the crack and repaired as specified in Article REPAIR OF ADMIX LINER. In the event that the geomembrane cannot be installed within 12 hours after placement of the final admix liner lift, the final lift of admix liner shall be constructed 4 to 6 inches thicker than required and cut to finish grade immediately before geomembrane deployment.

The Construction General Contractor shall take measures to prevent the admix liner from freezing. Lifts of admix liner shall not be placed on frozen surfaces. Geomembrane shall not be placed on a surface, which is frozen or has been frozen and thawed until directed by the Construction Manager and the CQA Certifying Engineer.

Repair of Admix Liner

The Construction General Contractor shall repair the surface of any areas identified to be out of tolerance. The size of the repair area shall be as required to remove and/or repair defective areas of the admix liner. Repair as follows:

Remove soil that does not meet specifications.

Scarify surface and spray with water.

Place additional approved admix material.

Compact soil with self-propelled pegfoot or padfoot type compactor as described above.

Trim and roll the surface as described above to design grades and tolerances.

Alternative methods for repair of the admix liner will be allowed if submitted by the Construction General Contractor and approved by the Engineer and Construction Manager.

Construction General Contractor will repair small holes (up to a maximum 6-inch diameter) resulting from sampling and other CQA activities. Such holes shall be repaired by backfilling with admix liner or powdered bentonite material in lifts of no more than 2-inch thickness and hand tamping with a steel rod or other suitable device to firmly compact each lift.

Construction Quality Assurance and Acceptance

Testing and criteria for admix liner acceptance is provided in the CQA Plan, which is made part of these Specifications by reference.

END OF SECTION 02666

SECTION 02667 - GEOSYNTHETIC CLAY LINER (GCL) SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
ASTM D5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liner
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners

Description

The Work includes supply and installation of geosynthetic clay liners (GCLs) for the landfill lining system as shown on the Drawings.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Submit manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the materials proposed for use comply with the requirements of these Specifications.

Submit manufacturer's quality control test results, written properties certification guarantee, and QC certificates, as specified in PART 2-PRODUCTS.

Construction Quality Assurance (CQA)

Quality assurance procedures are presented in the CQA Plan. CQA Plan requirements are discussed in Section 02661, GEOMEMBRANES. The Construction General Contractor shall accommodate all quality assurance activities described herein and in the Construction Quality Assurance Plan (CQA Plan) for this project.

Prior to placing any materials over the installed GCL, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA Conformance Testing

Prior to deployment of the GCL, CQA personnel will remove samples and forward them to an approved geosynthetics laboratory for testing to document conformance to both the design specifications and the list of guaranteed properties.

Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 50,000 square feet, whichever results in the greater number of tests. Samples shall be taken from any portion of the roll that has not been damaged. Unless otherwise specified, samples shall be 3 feet long by the roll width. The machine direction shall be marked on the samples with an arrow.

As a minimum, the following tests shall be performed on GCL:

1. Bentonite Swell Index: ASTM D5890.
2. GCL Index Flux: ASTM D5887.
3. Bentonite Mass per Unit Area: ASTM D5993.

The CQA Certifying Engineer shall be allowed to remove samples of GCL for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

Part 2 – Products

GCL

GCL shall be BENTOMAT(R) DN as manufactured by Colloid Environmental Technologies Co. (CETCO), Arlington Heights, IL; or Bentofix NWL as manufactured by GSE Lining Systems, Houston, TX; or approved equal, and shall meet the following requirements:

Property	Requirement	Test Method
Bentonite Mass/Area, lb/sq ft at 0%		
moisture content, MinARV	0.75	ASTM D5993
Bentonite Fluid Loss, mL, MaxARV	18	ASTM D5891
Bentonite Swell Index, mL/2g, MinARV	24	ASTM D5890
Grab Strength, lb, Tested Dry, MinARV	150	ASTM D4632
Peel Strength, lb, Tested Dry, MinARV	15	ASTM D4632
Index Flux, m^3/m^2/sec, MaxARV	$1x10^{-8}$	ASTM D5887
• 2 psi Water Head Pressure		
• 5 psi Effective Confining Pressure		
Permeability with Water, cm/sec, MaxARV	$5x10^{-9}$	ASTM D5084

Property	Requirement	Test Method
• 2 psi Water Head Pressure		
• 5 psi Effective Confining Pressure		
Finished GCL Roll Width, Feet, MinARV	14	Linear Measurement
Finished GCL Roll Length, Feet, MinARV	150	Linear Measurement

The bentonite in the GCL shall be a sodium montmorillonite clay.

The GCL shall be manufactured so that the bentonite shall be continuously contained throughout the GCL and to support the geotextiles so that no displacement of the bentonite occurs when the material is unrolled, moved, cut, torn, or punctured. GCL products that utilize an alternate edge system with grooves cut in seam overlap areas are permitted subject to approval of the Engineer.

Any adhesive used shall be inert, nontoxic, and water-soluble. GCL materials made without the use of adhesives shall be stabilized to contain the granular bentonite by a process such as needle punching or stitching through the top and bottom layers of geotextile and the bentonite.

Encapsulating geotextile materials shall be polypropylene, consisting of two nonwoven geotextile components, which are needle-punched together. The nonwoven components of the GCL shall have a nominal mass per unit area of 6 ounces per square yard needle-punched geotextile.

Quality control testing shall be carried out by the manufacturer to demonstrate that the GCL meets the specifications in this section. Tests shall be conducted on each production lot of GCL or every 50,000 square feet, whichever results in the greater number of tests.

The manufacturer shall provide a written guarantee that the GCL has the properties listed on the specification sheet.

The GCL manufacturer shall provide a quality control certification that the GCL has the properties listed on the specification sheet for each roll of GCL shipped to the project site. The quality control certificate shall be signed by a responsible party employed by the manufacturer, such as the production manager. The quality control certificate shall include:

1. Roll numbers and production lot identification.
2. Results of manufacturer quality control tests.
3. Results of bentonite supplier quality control tests for bentonite used in GCL production.

Accessory Bentonite

Accessory bentonite for seaming shall be as recommended by the GCL manufacturer.

Transportation, Handling, and Storage

Transportation of the GCL shall be the responsibility of the manufacturer, and the Construction General Contractor. All handling on site shall be the responsibility of the Construction General Contractor.

Upon delivery at the site, the Construction General Contractor shall observe the surfaces of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Construction General Contractor will determine:

Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.

Rolls that are not properly labeled. No unlabelled rolls shall be used for any application. Unlabelled rolls shall be removed from the site and replaced at the Construction General Contractor's expense.

The Construction General Contractor shall be responsible for the storage of the GCL onsite. The Construction General Contractor shall provide storage space in a location as shown on the Drawings or as approved by the Construction Manager such that on-site transportation and handling are optimized to the extent possible. Storage space shall be protected from theft, vandalism, passage of vehicles, etc. Stored GCLs shall be protected from moisture and other damaging conditions in accordance with the manufacturer's recommendations.

Part 3 – Execution

General

Install GCLs at the locations, lines, and grades shown on the Drawings. All GCLs shall be installed in accordance with these Specifications.

Materials and work, which fail to meet the requirements of these Specifications, shall be removed and disposed of at the Construction General Contractor's expense. This includes GCL rolls that are not labeled or where the label has deteriorated to the point of being illegible.

Handling And Placement

The Construction General Contractor shall handle and deploy all GCLs in such a manner as to ensure that they are not damaged.

Surface Preparation – Primary GCL

For the IDF project, primary GCL will be deployed over the CDN surface. Primary GCL shall be placed over a firm, unyielding surface. Wrinkle height in the underlying LDSCDN shall be minimized as to allow primary GCL deployment on a flat unyielding surface. Maximum wrinkle height for geosynthetics is specified in Section 02661, GEOMEMBRANES.

Surface Preparation – Secondary GCL

As specified in Section 02319, SUBGRADE PREPARATION.

Deployment

GCL shall be deployed so that seams run up and down (not across) the slope.

Prior to placement of cover material over the GCL and HDPE geomembrane, the moisture content of the bentonite component of the GCL shall not exceed 100 percent.

Only areas of GCL suspected of exposure to excessive moisture, in the judgment of the CQA Certifying Engineer, shall be sampled for moisture content. GCL panels with bentonite component moisture content greater than 100 percent shall be removed and replaced at Construction General Contractor's expense, regardless of the source of moisture, including adsorption from subgrade soil and/or condensation under the HDPE geomembrane or temporary plastic cover.

Any wrinkles in excess of the maximum wrinkle height specified in Section 02661, GEOMEMBRANES, shall be reduced to below specified height by adjusting and smoothing the GCL after placement.

GCL shall not be deployed during precipitation or in the presence of moisture, ponded water, snow, or in other situations that could cause premature hydration of the bentonite. Any GCL that hydrates prematurely shall be removed and replaced at the Construction General Contractor's expense.

The panels shall be placed to provide an overlap of 6 inches on longitudinal (edge of roll) seams, regardless of slope steepness. The panels shall be placed to provide an overlap of 24 inches on transverse (end of roll) seams for slopes flatter than 6H:1V. No transverse seams shall be allowed on slopes 6H:1V and steeper.

No more GCL shall be deployed than can be covered with geomembrane or other protective layer the same day.

Provide protection from wind uplift as necessary using sandbags or other method that will not damage the GCL.

Overlapping GCL Panels

Overlap marks 6 inches from the panel edge shall be marked longitudinally on the GCL to assist in obtaining the proper overlap.

Prior to lapping, remove all dirt, gravel, or other debris from the overlap area. Apply 1/4 pound of accessory per linear foot of seam. Lap areas that have been contaminated by soil and/or sand shall receive additional accessory bentonite in the amount of 1/4 pound per linear foot evenly spread across the longitudinal seam area. GCL products with alternate edge treatment system with grooves cut in the seam overlap area that eliminate the requirement for accessory bentonite, are permitted for edge of roll seams with prior approval by the Engineer. Accessory bentonite shall be required for end of roll seams.

End of roll overlap on slopes less than 6H:1V shall be shingled so that the direction of flow is from the top panel onto the bottom panel.

On slopes 6H:1V and steeper, the panels shall be placed with the long dimension (length) continuous from the crest to the toe and the upper end anchored in a trench with soil backfill as shown on the Drawings.

Repairs

Replace or repair damaged or hydrated areas of GCL.

Place a patch of GCL that extends at least 12 inches beyond the edges of the damaged area in all directions.

Overlap areas shall conform to requirements for seams described above.

Placement Of Overlying Materials On Geosynthetic Clay Lining

The GCL shall be completely covered with HDPE geomembrane or temporary plastic cover and protected at the end of each shift or workday. The Construction General Contractor shall be fully responsible to protect the GCL from damage, shrinkage, or prehydration and shall replace all affected materials at the Construction General Contractor's sole expense.

To prevent premature hydration or shrinkage in hot weather, only the amount of GCL that can be anchored, inspected, repaired, and covered with HDPE geomembrane or temporary plastic cover in the same day shall be installed.

Equipment used to install the overlying materials shall not operate directly on the GCL.

Construction General Contractor shall use a “rub sheet” of smooth HDPE geomembrane between the GCL and textured HDPE geomembrane to prevent damage to the GCL while maneuvering the textured HDPE geomembrane into position for seaming. Construction General Contractor shall develop method(s) of removing rub sheet that, after maneuvering textured HDPE geomembrane into place, prevents damage to toe underlying GCL.

Overlying materials shall be placed over the GCL and HDPE geomembrane as specified in Section 02661, GEOMEMBRANES.

END OF SECTION 02667

SECTION 02920 – RECLAMATION AND REVEGETATION SCHED. A & B

Part 1 – General

Summary

This section includes, but is not limited to, stabilization measures to prevent wind and water caused erosion of areas disturbed by the construction.

References

ASTM INTERNATIONAL (ASTM)

ASTM D586 Standard Test Method for Ash in Pulp, Paper, and Paper Products

Submittals–Approval Required

See Section 01300, SUBMITTALS, for procedures.

Manufacturer's technical data and installation recommendations for erosion control matting, including type and spacing of anchorage devices.

Manufacturer's written certification that wood fiber mulch product contains less than 250 parts per million boron, is nontoxic to plant and animal life, and satisfies the specified organic matter content as determined by ASTM D586.

Submittals–Approval Not Required

Information/Record (IR):

Tackifier and Mulch: Submit manufacturer's information and/or product data sheets for the tackifier selected for use on this project. Include confirmation of the application rate, which will be used. Submit Material Safety Data Sheets for the tackifier and any dye used in the tackifier and mulch application.

Installation warranty.

Part 2 – Products

Materials:

Topsoil: Strippings that are free from toxic minerals, noxious weeds, and other objectionable material shall be used for topsoil in accordance with Section 02200, SITE PREPARATION. Vegetation shall be removed during clearing and grubbing in accordance with Section 02200, SITE PREPARATION. The removed vegetation, other than noxious weeds, shall be reduced to pieces that are no larger than 1 inch in any dimension and shall be incorporated uniformly into the strippings. Large clods, hard lumps, rocks 2 inches in diameter and larger, and litter shall be removed from the topsoil.

Topsoil shall be stockpiled in accordance with Section 02200, SITE PREPARATION.

Grass Seed: Grass seed shall be crested wheatgrass var. Nordan. The grass seed shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification," latest edition.

Seed shall be furnished in standard containers on which shall be shown the following information:

Common name of seed.

Lot number.

Net weight.

Percentage of purity.

Percentage of germination.

Percentage of weed seed content and inert material clearly marked in accordance with applicable state and federal laws.

The maximum allowable noxious weed percentage (by weight) is 0.5 percent. The maximum allowable inert percentage is 7 percent.

Upon request, the Construction General Contractor shall furnish to the Construction Manager duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months before the date of delivery on the project. Seed, which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

Fertilizer: Fertilizer shall be either fertilizer Type A or fertilizer Type B.

Fertilizer Type A shall be an organic product developed from byproducts of the manufacture of various antibiotics, enzymes, and proteins. Fertilizer Type A shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 7-2-3 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type A shall be sterilized and weed free. Fertilizer Type A shall be supplied in dried, granulated form with the dried weight, contents, and chemical analysis clearly marked on each bag. One suggested product name for fertilizer Type A is Biosol Mix, Rocky Mountain Bio-Products, Inc., Edwards, CO.

Fertilizer Type B shall be an organic product manufactured from seedmeal (60 percent), protein-derived, and fortified with calcium-rich (300 pounds per ton) composted chicken manure. Fertilizer Type B shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 6-4-1 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type B shall be biodegradable, nonpolluting, nonvolatile, nontoxic, sterilized and weed free, and contain no heavy metals or salts. Fertilizer Type B shall be supplied in dried, pelletized form with the dried weight, contents, and chemical analysis clearly marked on each container. One suggested product name for fertilizer Type B is Fertile-Fibers Nutrimulch™, Quattro Environmental, Coronado, CA.

Wood Fiber Mulch: Wood fiber mulch shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. The fibers shall not contain any rock, metal, or plastic. It shall be suitable for hydromulching and shall be treated with a nontoxic green dye to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture. The product shall contain less than 250 parts per million boron and shall be nontoxic to plant and animal life. The organic matter content shall be at least 93 percent on any oven-dry basis as determined by ASTM D586. The moisture content shall be no more than 15 percent as determined by oven-dried weight. Each package of the wood fiber mulch shall be marked by the manufacturer to show the dried weight. Wood fiber mulch shall be added to the tackifier at the rate of 1,500 pounds per acre minimum.

Straw Mulch: Straw mulch shall be air dried straw free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.

Tackifier: The tackifier shall be an organic guar tackifier derived form natural organic plant sources or a 100 percent polyacrylamide. The tackifier used shall contain no growth or germination inhibiting materials. The guar based tackifier shall be applied at a rate of 60 pounds per acre minimum. If polyacrylamide is used as the tackifier instead of guar, it shall be applied at 5 pounds per acre minimum.

Erosion Control Matting:

Erosion control matting shall be used to prevent erosion of soil due primarily to wind. Erosion control matting shall be a long-life dense matting composed of nylon fiber, polyolefin fiber, or polyester fibers.

The matting shall be of a consistent thickness with the fiber evenly distributed over the entire area of the matting. The fibers shall be encased between two layers of heavy polypropylene or polyolefin netting. The fibers and the netting shall be stitched top to bottom to form a three-dimensional matrix using polyester or polyolefin thread. All components of the erosion control matting shall be stabilized against ultraviolet degradation and inert to chemicals normally encountered in a natural soil environment. The erosion control matting shall have a minimum thickness of 0.5 inch and a minimum weight of 10 ounces per square yard. Three suggested product names for erosion control matting are Landlok ECRM 450, Synthetic Industries, Chattanooga, TN; P300, North American Green, Evansville, IN; and Recylex TRM, American Excelsior Company, Arlington, TX.

Anchorage devices for erosion control matting shall be as recommended by the manufacturer of the erosion control matting and as approved by the Construction Manager.

Soil Stabilization Cover: Soil stabilization cover shall be applied on the finished grade inside side slopes of the Phase I excavation to reduce wind and water caused erosion. Soil stabilization cover shall be a waterborne copolymer emulsion consisting of nonflammable concentrated PVA liquid copolymer with acrylic base having 60 percent solids. On drying the soil stabilization cover shall from a colorless transparent net-like film. Such film shall have permeability to allow exchange of air and moisture and have an effective life of at least 1 year. The copolymer shall not re-emulsify when cured. The liquid copolymer emulsion shall be nontoxic to plants and animals. One suggested product name for soil stabilization cover is Marloc, Reclamare Company, Des Moines, WA.

Part 3 – Execution

Placing Topsoil

A 6-inch thick layer of topsoil, or as otherwise ordered by the Construction Manager, shall be evenly spread over all areas where material has either been excavated from or has been placed in that are to be seeded, including all borrow areas and permanent stockpiles.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Construction Manager in a condition detrimental to the work.

Upon physical completion of the work, remaining topsoil shall be stockpiled at the location shown on the Drawings. The permanent topsoil stockpile shall than be seeded, fertilized, and mulched.

Seeding, Fertilizing, And Mulching

General: Areas to be seeded, fertilized, and mulched are indicated on the Drawings. No seeding, fertilizing, and mulching shall be done within the Phase I excavation, unless directed otherwise by the Construction Manager. Areas to be seeded, fertilized, and mulched include at a minimum the east and west infiltration areas, the berm and ditch located south of the Phase I excavation, soil stockpiles that will remain after the completion of the construction, and borrow areas. Other areas outside of the Phase I excavation that are disturbed by the construction and are not otherwise stabilized shall be seeded, fertilized, and mulched as directed by the Construction Manager.

Season of Work: Seeding shall be done between September 1 and March 1. Specific ideal seeding times within this window shall be as required for proper seedbed preparation.

Weed Control: Areas to be seeded shall be maintained reasonably free of weeds. Weeds shall be kept from going to seed.

Seedbed Preparation:

Soil shall be tilled to a minimum depth of 6 inches. The seedbed shall be firm below seeding depth and well pulverized and loose on top. It shall be free of clods and weeds. Tillage shall leave cross-slope furrows. Seedbed preparation shall not be performed when soil conditions are not suitable for tilling: too dry, too wet, frozen, etc.

Areas to be seeded that have not either had material excavated from them or placed in them shall not receive any seedbed preparation unless directed otherwise by the Construction Manager. The seedbed preparation would destroy any existing soil crust. Existing soil crust provides erosion protection.

Application of Seed and Fertilizer: Seeding and fertilizing shall be done closely following seedbed preparation and shall not be done during windy weather or when the ground is frozen or excessively wet. The Construction General Contractor shall notify the Construction Manager not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Construction Manager's approval, seeding of the approved areas shall begin immediately.

Seed and fertilizer shall be applied by one of the following methods:

Hydroseeding: Use a hydroseeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydroseeder tank no more than 1 hour prior to application.

Hand Broadcasting:

Apply fertilizer first. The seed shall be incorporated into the top 1/4 inch of soil by hand raking or other method that is approved by the Construction Manager.

Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Seed shall be applied at a rate of 10 to 12 pounds pure live seed per acre. Fertilizer shall be applied at a rate of 1,000 pounds per acre.

Mulching:

Straw mulch shall be evenly applied at a rate of 1.0 ton per acre within 48 hours after seeding. Mulching shall not be performed when wind interferes with mulch placement. Distribution of straw mulch material shall be by means of a mulch spreader that utilizes forced air to blow mulch material on the seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Straw mulch may be spread by hand over areas that were seeded by hand. Straw mulch shall be crimped into the soil to a depth of 2 inches and with no more than one pass of the equipment.

In areas where it is not possible to crimp the straw mulch into the soil, tackifier shall be applied over the straw mulch. The method of application for tackifier shall be in accordance with the manufacturer's instructions. The tackifier application rate shall be as specified herein. Tackifier shall be sprayed over mulch, seed, and fertilizer. The Construction Manager shall indicate which areas (if any) shall have the straw mulch held down with tackifier.

Mulching can be accomplished by either hydromulching with wood fiber mulch, or by mulch spreader (or by hand) with straw mulch. Using hydromulching, wood fiber mulch will be added to the tackifier at the rate of 1,500 pounds per acre, in addition to the mulch used as tracer for hydroseeding.

Protection: Traffic over seeded areas shall be prohibited.

Installation Warranty:

The warranty period for seeding, fertilizing, and mulching will begin upon the date of acceptance of the completed installation. The installation shall be considered complete by the Construction Manager upon satisfactory completion of the initial inspection, which is described below. Acceptance will be certified in writing by the Construction Manager.

Seeded areas shall be guaranteed by the Construction General Contractor for a period of 1 year. Mulch coverage will be used to evaluate the materials and workmanship of the application of seed, fertilizer, and mulch. Seed, fertilizer, and mulch will be reapplied one time only as directed by the Construction Manager at the Construction General Contractor's expense in areas where the coverage does not meet the following criteria. Three inspections of mulch coverage will occur:

Initial inspection will occur between 1 to 3 business days following completion of the installation for the purposed of Construction Manager acceptance. Mulch coverage must equal 100 percent of the area over which it was spread before Construction Manager acceptance will occur.

Mulch coverage will be inspected 60 days after Construction Manager acceptance at which time mulch coverage must equal 100 percent of the area over which it was spread.

A final inspection will occur 30 days prior to the end of the warranty period. At this time, mulch coverage must equal at least 80 percent of the area over which it was spread.

Placing Erosion Control Matting

Erosion control matting shall be installed in the locations shown on the Plans and as directed by the Construction Manager. The erosion control matting shall be securely anchored to resist the wind. The erosion control matting shall be installed following the manufacturer's recommendations and the following minimum requirements. Where more than one strip of erosion control matting is required, it shall overlap the adjacent matting a minimum of 6 inches. The ends of the erosion control matting shall overlap a minimum of 6 inches with the uphill section on top.

Placing Soil Stabilization Cover

Soil stabilization cover shall be applied with hydroseeding equipment in two passes of opposite directions. Copolymer shall be applied at a minimum rate of 200 gallons per acre; dilution rate for copolymer and water shall be per the manufacturer's recommendation. Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Soil stabilization cover shall be applied when adequate weather conditions for proper curing, as determined by the manufacturer, are anticipated. The Construction General Contractor shall apply soil stabilization cover only to finish graded areas unless directed otherwise by Construction Manager.

END OF SECTION 02920

DIVISION 3–CONCRETE

SECTION 03301 - CONCRETE SCHED. A & B

Part 1 – General

Work Included

This section is a ready-mix concrete and reinforcing bar specification for concrete.

References

The following is a list of standards, which may be referenced in this section:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318/318R	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C33	Standard Specification for Concrete Aggregates.
ASTM C39	Standard Test Methods for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C94	Standard Specification for Ready-Mix Concrete.
ASTM C150	Standard Specification for Portland Cement.
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete.
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
ASTM C494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI Manual of Standard Practice.

Recommended Practice for Placing Reinforcing Bars.

1997 UNIFORM BUILDING CODE (UBC)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Reinforcing steel in accordance with CRSI Manual of Standard Practice and ACI SP-66, Detailing Manual.

Curing compound data.

Complete data on the concrete mix, including aggregate gradations and admixtures, in accordance with ASTM C94.

Statement identifying aggregates reactivity.

Concrete mix design signed by a qualified mix designer that is a licensed professional engineer in the State of Washington.

Submittals–Approval Not Required

Information/Record (IR):

Qualifications of independent qualified testing laboratory for concrete construction quality control.

Manufacturer's application instructions for curing compound.

Statement for batch plant currently certified by the National Ready Mixed Concrete Association. If batch plant cannot be certified, then Construction General Contractor shall demonstrate to the Construction Manager's satisfaction by providing additional testing as determined by the Construction Manager such that the concrete may be determined to be acceptable. These test results shall be submitted to Construction Manager.

Certification for proper functioning of concrete transport trucks including blades, drum rotators, counters, and other components. Certification shall be acceptable only for concrete batch plants certified by the National Ready Mixed Concrete Association. Batch plants that are not certified shall require concrete transport trucks to undergo independent assessment to the satisfaction of the Construction Manager.

Ready-mix delivery tickets for each truck in accordance with ASTM C94.

Concrete crack repair epoxy injection statement of qualifications for manufacturer's site representative, injector applicator, and injector pump operating technician. Submit only if crack repair is required.

Pour slip shall be required prior to any concrete placement to serve as a checklist between the Construction Manager and the Construction General Contractor. This checklist will be used to document Construction General Contractor's readiness for concrete placement. Pour slip form shall be provided to the Construction General Contractor from the Construction Manager.

Results of construction quality control testing.

Environmental Requirements

Do not place concrete when the ambient temperature is below 40 degrees F or approaching 40 degrees F and air temperature less than 40 degrees F for the first 7 days, without special protection to keep concrete above 40 degrees F.

Do not use curing compound where solvents in the curing compounds are prohibited by state or federal air quality laws.

Form sealer shall be a ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations.

Part 2 – Products

Form Materials

All formwork shall conform to the guidelines in ACI 347.

Forms for Exposed Finish Concrete:

Provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without visible bow or deflection:

Plywood shall comply with American Plywood Association, grade "EXT-DFPA PLYFORM" or better.

Forms for Unexposed Finish Concrete: Form concrete surfaces, which will be, unexposed in finished structure with plywood, lumber, or metal.

Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

Form Ties:

Steel form ties with conical or spherical spreader insert that will leave no metal closer than 1 inch to concrete surface after tie ends are removed. Wire ties shall not be used.

Water stop ties shall be perpendicular to water stop and symmetrical about the center of tie and designed to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along the tie. Maximum spacing shall be 12 inches, and all corners shall be tied.

Concrete Materials

Portland Cement: Cement shall conform to ASTM C150, Type I-II. The cement shall contain no more than 0.60 percent by weight of alkalies calculated as (Na_2O + 0.658 K_2O).

Pozzolans: Pozzolans (fly ash) shall conform to ASTM C618 Class C or Class F, except that the loss on ignition (LOI) shall be less than 2 percent.

Aggregate: Fine and coarse aggregate shall conform to ASTM C33. Maximum coarse aggregate size shall conform to ACI 318, paragraph 3.3.2. Unless otherwise specified, maximum aggregate size shall be

1-1/2 inches. Aggregate shall be nonpotentially reactive in accordance with ASTM C33, Appendix XI, paragraph X1.1.

Mixing Water: Potable having no pronounced taste or odor, and containing no deleterious materials.

Air-Entraining Agents (AEA): ASTM C260.

Water-Reducing Admixtures: If water-reducing admixtures are used, they shall conform to ASTM C494, Type A, and contain no more than 1 percent chloride ions.

Calcium Chloride: Calcium chloride is not permitted.

Reinforcing Steel

Deformed Bars: ASTM A615, Grade 60. Welding of reinforcing shall not be permitted.

Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place. Use wire bar type supports complying with CRSI recommendations, or approved substitute. Use supports with sand plates or horizontal runners where base material will not support chair legs. Pumice blocks, adobe, bricks, rocks, etc. are not acceptable for rebar or wire mesh supports.

Ancillary Materials

Concrete Crack Repair Epoxy Injection Manufacturers:

- Contech Group, Seattle, WA, or Portland, OR.
- Sika Group, Lindhurst, NJ.
- Euclid Chemical Co., Cleveland, OH.

Expansion Joint Filler: ASTM D994, 1/2 inch thick, or as shown.

Nonshrink Grout:

Color: To match concrete.

Manufacturers and Products

- Master Builder Co., Cleveland, OH; Master Flow 928.
- Euclid Chemical Co., Cleveland, OH; Hi-flow Grout.

Curing Compound:

Material: Water-based curing compound in accordance with ASTM C309, Type I or Type 1D, with additional requirement that the moisture loss not exceed 0.040 gram per centimeter squared per 72 hours.

Manufacturers and Products:

- Master Builders Co.; Masterkure 200W.
- Euclid Chemical Co.; Super Diamond Clear Vox.

Water Stop: Extruded elastomeric plastic compound with basic resin to be polyvinyl chloride.

Manufacturers and Products:

Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN, RB6-38H.

A. C. Horn, Inc., Beltsville, MD; Catalog No. CSP-162, Type 9 (6-inch by 3/8-inch).

Hydrophilic Water Stop: Material shall be a non-bentonite hydrophilic rubber compound. Material shall be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.

Manufacturers and Products:

Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-K with Leakmaster LV-1 adhesive and sealant.

Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

Red Coloring for Electrical Duct Encasement: Commercial grade red iron oxide, 3 pounds per sack of cement.

Concrete Slab Coating

As specified in Section 09900, PAINT COATING SYSTEMS.

Proportioning and Design of Mixes

Mix Design: Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 318 and 1997 UBC. The more stringent requirements of ACI 318 and 1997 UBC shall apply. Existing mix design test records shall be acceptable only if the facility is certified by National Ready Mixed Concrete Association. Uncertified concrete batch plant shall require testing from a qualified independent testing agency to develop the test and number of tests for an acceptable standard deviation to be developed.

Design mixes to provide normal weight concrete with the following specified 28-day compressive strengths, minimum, as indicated on drawings and schedules:

Class 30: 3,000 psi (non-structural concrete elements such as sidewalks, guard posts, fences, post and pole foundations, conduit encasement, and thrust blocks).

Class 40: 4,000 psi (structural concrete).

Class 50: 5,000 psi (truck loading pad).

See CONSTRUCTION QUALITY CONTROL of this specification for acceptance criteria.

Concrete mixes incorporating pozzolan (fly ash) shall contain a minimum of 15 percent fly ash by weight and the maximum 25 percent fly ash of the total cementitious materials.

Class 40 and Class 50 air content shall be 4 to 6 percent when tested in accordance with ASTM C231.

Follow manufacturer's recommendations for addition of water reducers.

Class 40 and Class 50: Concrete shall be air-entrained and shall incorporate the usage of high-range water reducer. Concrete mix design shall contain fly ash. Add air entraining agent (AEA) at the manufacturer's prescribed rate to result in concrete at point of placement having air content complying with ACI 301.

Unless specifically stated otherwise, water-cement ratio (or water-cement plus fly ash ratio) shall control amount of total water added to concrete as follows:

Water-Cement Ratio	**Maximum W/C Ratio**	**Maximum W/C Ratio**
Coarse Aggregate Size	**w/Superplasticizer**	**w/o Superplasticizer**
1-1/2"	0.40	0.45
1"	0.40	0.45
3/4"	0.40	0.45

Slump Range at Site(Class 40 and Class 50):

4-1/2 inches minimum, 8 inches maximum for concrete with a high range water reducing admixture.

3 inches minimum and 5 inches maximum for concrete without high range water reducing admixture.

Combined Aggregate Gradation:

Select one of the gradations shown in the following table.

Combined Gradation Limits:	Limits shown are for coarse aggregates and fine aggregates mixed together (combined).			
		Combined Gradation		
		Percentage Passing		
	Sieve Sizes	**1-1/2" Max.**	**1" Max.**	**3/4" Max.**
	2"	- 100	-	-
	1-1/2"	95 - 100	- 100	-
	1"	65 - 85	90 - 100	- 100
	3/4"	55 - 75	70 - 90	92 – 100
	1/2"	-	-	68 – 86
	3/8"	40 - 55	45 - 65	57 – 74
	No. 4	30 - 45	31 - 47	38 – 57
	No. 8	23 - 38	23 - 40	28 – 46
	No. 16	16 - 30	17 - 35	20 – 36
	No. 30	10 - 20	10 - 23	14 – 25
	No. 50	4 - 10	2 - 10	5 – 14
	No. 100	0 - 3	0 - 3	0 – 5
	No. 200	0 - 2	0 - 2	0 – 2

Minimum Cement Content (or Combined Cement Plus Fly Ash Content When Fly Ash is Used):

517 pounds per cubic yard for concrete with 1-1/2-inch maximum size aggregate.

540 pounds per cubic yard for 1-inch maximum size aggregate.

564 pounds per cubic yard for 3/4-inch maximum size aggregate.

Increase cement content or combined cement plus fly ash content, as required to meet strength requirements and water-cement ratio.

Mixing And Delivery (Class 40 and Class 50)

The manufacture and delivery of all concrete shall conform to ASTM C94 except as modified herein. Hand-mixed concrete is prohibited.

When concrete arrives at the jobsite with slump below that suitable for placing, as indicated by the Specification, water may be added only if the maximum permissible water-cement ratio and the maximum permissible slump is not exceeded. Any water thus added to bring the slump within required limits shall be injected in such a manner that uniformity requirements are met. Water shall be incorporated by additional mixing equal to at least half of the total mixing required or 30 drum revolutions at rated mixing speed, whichever is more. Additional AEA may be introduced during this mixing period if necessary to meet Specifications. Neither water nor AEA shall be added to the batch at any later time.

Concrete uniformity shall meet the requirements of ASTM C94 except as modified herein. After final mixing is complete, visible lumps, nonconformance to uniformity requirements, or failure to meet specified slump, entrained air, and temperature requirements shall be considered cause for rejecting the remainder of the load. In addition, failure of the ready-mix truck drum to meet uniformity requirements will be deemed cause for rejection of the mixing equipment until adequate repairs have been made.

Discharge of the concrete shall be completed within 1-1/2 hours, or before the drum has revolved 300 revolutions, whichever comes first, after the introduction of mixing water to the cement and aggregates unless special approved time delay admixtures are used. Coordinate time delay admixture information with manufacturer and Construction Manager prior to placing concrete. In hot weather or under conditions contributing to quick stiffening of the concrete a time limit less than 1-1/2 hours may be designated by the Construction General Contractor.

Additional high-range water-reducing admixtures (superplasticizer) may be added to the mixer at the jobsite using manufacturer-approved dispensing when unexpected delays cause too great of slump loss.

Concrete that is rejected for failure to meet any of the above requirements will be evaluated by the Engineer and may be removed and replaced at the expense of the Construction General Contractor.

Hot or Cold Weather Concreting: Methods and means of batching, mixing, and delivery of concrete in hot or cold weather shall comply with ACI 305R or ACI 306.1.

Part 3 – Execution

Formwork

Unless otherwise shown on the drawings, all forms shall be straight and plumb, rigid and mortar tight. All forms shall be braced, tied, and supported sufficiently to maintain their required position during and after the placing of concrete. Joints shall be sufficiently tight to prevent mortar leakage. Where shown on the Drawings, embedded items shall be placed in forms to shape edges or surfaces to that of the concrete members. All formwork shall conform to the guidelines in ACI 347.

All exposed corners of concrete shall be chamfered 3/4 inch.

Form Removal:

Formwork Not Supporting Weight of Concrete: This formwork may be removed after cumulatively curing at not less than 50 degrees F for 32 hours after placing concrete, provided concrete is sufficiently hard not to be damaged by form removal or subsequent operations. Curing must then continue through the minimum curing period.

Formwork Supporting Weight of Concrete: This formwork may not be removed until concrete has attained its 28-day design compressive strength, except as permitted under "Early Loading of New Concrete" as specified below.

Early Loading of New Concrete: Early loading of concrete structures shall comply with requirements of ACI 318, Section 6.2. When construction loading is proposed before concrete has achieved its 28-day design strength, structural calculations and concrete strength test data shall be submitted and approved by the Construction Manager prior to loading.

Form Sealer:

Material: Surface sealer will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces when applied to forms.

Manufacturers and Products:

Master Builders, Inc.; Rheofinish.

Burke Chemicals; Burke Release No. 1.

Placing Reinforcing Steel:

Unless otherwise specified, place reinforcing steel in accordance with CRSI Recommended Practice for Placing Reinforcing Bars and ACI 301.

Splicing:

Follow ACI 318/318R.

Use lap splices, unless otherwise shown or permitted in writing by Engineer.

Stagger splices in adjacent bars where indicated.

Placing Concrete

Place concrete in accordance with ACI 301.

Prior to placing concrete, remove water from excavation and debris and foreign material from forms. Check reinforcing steel for proper placement and correct discrepancies.

Before depositing new concrete on old concrete, clean surface using sandblast or bushhammer or other mechanical means to obtain a 1/4-inch rough profile, and pour a cement-sand grout to minimum depth of 1/2-inch over the surface. Proportion 1 part cement to 2.5 parts sand by weight.

Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 2 feet deep. Place within 1-1/2 hours after adding cement to mix.

Eight feet maximum vertical drop to final placement, when not guided with chutes or other devices to prevent segregation due to impact with reinforcing.

Concrete shall be placed near its final location to avoid segregation.

Cold Weather Placing: Protect concrete work from damage or reduced strength, which could be caused by frost, freezing, or low temperatures, in compliance with ACI 306.1 and as specified herein. Minimum concrete temperature as placed and maintained shall be 55 degrees F, or as required by ACI-306.1, Table 3.2.1.

Hot Weather Placing:

When hot weather conditions that would seriously impair quality and strength of concrete exist, place concrete in compliance with ACI 305 and as specified herein:

Cool mixing drum and/or ingredients before mixing to maintain concrete temperature below 90 degrees F at time of placement.

Compaction

Vibrate concrete as follows:

Apply approved vibrator at points spaced not farther apart than vibrator's effective radius.

Apply close enough to forms to vibrate surface effectively but not damage form surfaces.

Vibrate until concrete becomes uniformly plastic.

Vibrator must penetrate fresh placed concrete and into previous layer of fresh concrete below.

Vibrator shall not be used to move concrete.

Construction Joints

Locate as shown or as approved.

Provide waterstops in construction joints as indicated and with other Construction General Contractor-required construction joints that is approved by the Engineer.

Maximum Spacing Between Construction Joints: 40 feet.

Installation of Embedded Items

Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by cast-in-place concrete. Secure all such items firmly in position.

Finishing

Floor Slabs and Tops of Walls:

Finish slabs to grades shown on Drawings.

Screed surfaces to true level planes.

After initial water has been absorbed, float with wood float and trowel with steel trowel to smooth finish free from trowel marks.

Do not absorb wet spots with neat cement.

Unexposed Slab Surfaces: Screed to true surface, bull float with wood float, and wood trowel to seal surface. Finish surfaces to grades shown on Drawings.

Tolerances: Floors shall not vary from level or true plane more than 1/4-inch (plus or minus) in 10 feet when measured with a straightedge. Floors shall conform to grades shown on Drawings. Conform to ACI 117.

Exterior Slabs and Sidewalks:

Bull float with wood float, wood trowel, and lightly trowel with steel trowel.

Finish with broom to obtain nonskid surface.

Finish exposed edges with steel edging tool.

Mark walks transversely at 5-foot intervals with jointing tool.

Finishing And Patching Formed Surfaces

Smooth Form Finish (SmFm):

Provide as-cast smooth form finish for formed concrete surfaces that are exposed to view, or that are covered with a coating material applied directly to concrete, or a covering material bonded to concrete such as waterproofing, damp proofing, painting, or other similar system.

Produce smooth form finish (SmFm) by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

Cut out honeycombed and defective areas.

Cut edges perpendicular to surface at least 1 inch deep. Do not feather edges. Soak area with water for 24 hours.

Patch with nonshrink grout.

Finish surfaces to match adjacent concrete.

Keep patches damp for minimum 7 days or spray with curing compound to minimize shrinking.

Fill form tie holes with Nonshrink Grout.

Concrete Protection And Curing

General:

Protect freshly placed concrete from injurious action by sun, rain, wind, flowing water, mechanical injury, and premature drying for not less than seven (7) consecutive days after placement.

Protect concrete against damage from frost or freezing for a minimum of 3 days. Provisions of ACI 306.1 shall apply for cold weather unless otherwise specified.

Remove and replace concrete damaged by freezing.

Curing Methods: Perform curing of concrete by one or more of the following methods:

Moist Curing: Cover concrete surfaces with moisture retaining cover for curing period. Exposed horizontal concrete surfaces may be covered with sand or other approved material and kept wet for the required period. Wood forms shall be kept sufficiently wet at all times to prevent the forms from separating at the joints and the concrete from drying.

Membrane Curing: Concrete surfaces to receive membrane curing shall be treated with a curing compound as specified or otherwise approved. The curing compound shall be applied in strict accordance with the directions of the manufacturer of the compound.

Temperature, Wind, and Humidity:

Cold Weather:

When the mean daily outdoor temperature is less than 40 degrees F, the temperature of the concrete surface shall be maintained between 55 and 90 degrees F for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases that contain carbon dioxide. If early loading is anticipated during cold weather, provide temperature protection to ensure necessary strength development.

The concrete surface temperature requirements (based on section thickness) in ACI 306.1 may be used in lieu of the 55 degrees F minimum specified before.

If concrete surface temperatures as measured by the inspecting agency are below the minimum curing temperature but meet the freeze protection requirements, the concrete curing period shall be extended to ensure adequate strength is developed. The extension time shall be at least equivalent to the time period in which temperatures were too low.

Hot Weather: The concrete surfaces shall be kept below 100 degrees F for the curing period. When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

Rate of Temperature Change:

Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5 degrees F in any 1-hour or 50 degree F in any 24-hour period.

Use curing compound only where approved by Construction Manager. Cure formed surfaces with curing compound applied in accordance with manufacturer's directions as soon as forms are removed and finishing is completed.

Water Stops: Plastic and Hydrophilic

Install in accordance with manufacturer's instructions.

Repairing Concrete Cracks

Cracks requiring repair shall be determined by the Engineer and shall be repaired using epoxy injection. Method of epoxy injection shall be approved by the Construction Manager prior to application.

Construction Quality Control

Construction General Contractor Supplied Testing: The Construction General Contractor shall provide the necessary testing and monitoring services for the following:

Construction General Contractor shall procure the services of a qualified independent testing laboratory to control or monitor the production, transportation, placement, protection, curing, or temperature of the concrete as specified herein. Construction General Contractor shall submit qualifications of independent testing laboratory.

Evaluation of Concrete Field Strength:

Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, Samples used shall be taken from discharge end of pump hose.

Evaluation will be in accordance with ACI 301, Chapter 17, and Specifications.

Specimens shall be made, cured, and tested in accordance with ASTM C31 and ASTM C39.

Pumped Concrete: Take concrete samples for slump (ASTM C143) and test cylinders (ASTM C31 and C39).

Reject concrete represented by cylinders failing to meet strength and air content specified. For Class 30 concrete, reject concrete represented by cylinders failing to meet strength specified.

END OF SECTION 03301

DIVISION 4–MASONRY (NOT USED)

DIVISION 5–METALS

SECTION 05500 – METAL FABRICATIONS AND CASTINGS SCHED. A & B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

THE ALUMINUM ASSOCIATION, INC. (AA)

The Aluminum Design Manual

AMERICAN GALVANIZERS ASSOCIATION (AGA)

Inspection of Products Hot-Dip Galvanized After Fabrication

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S329	Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Stainless Steel Types

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.11	Safety Requirements for Personnel and Debris Nets
ANSI A14.3	Ladders - Fixed - Safety Requirements
ANSI B1.1	Unified-inch Screw Threads (UN and UNR Thread Form)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	Specification for Carbon Structural Steel
ASTM A48	Specification for Gray Iron Castings
ASTM A53/A53M	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A123/A123M	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

ASTM A153/A153M	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A240/A240M	Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A278	Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degree
ASTM A283/A283M	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile
ASTM A325	Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A489	Specification for Carbon Steel Lifting Eyes
ASTM A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A563	Specification for Carbon and Alloy Steel Nuts
ASTM A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Specification for Rolled Floor Plate, Stainless Steel
ASTM A967	Specification for Chemical Passivation Treatments for Stainless Steel Parts

ASTM A992/A992M	Specification for Steel for Structural Shapes for Use in Building Framing
ASTM B209	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B308/B308M	Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632/B632M	Specification for Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Specification for Hardened Steel Washers
ASTM F468	Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F593	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Specification for Stainless Steel Nuts
ASTM F844	Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

Evaluation Reports for Concrete and Masonry Anchors

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1910.27	Fixed Ladders
29 CFR 1926.105	Safety Nets
29 CFR 1926.502	Fall Protection Systems Criteria and Practices

SPECIALTY STEEL INDUSTRY OF NORTH AMERICA (SSINA)

Specifications for Stainless Steel

Design Guidelines for the Selection and Use of Stainless Steel

Stainless Steel Fabrication

Stainless Steel Fasteners

Definitions

Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

Exterior Area: Location not protected from the weather by a building or other enclosed structure.

Interior Wet Area: Location inside building or structure where floor is sloped to a sump, floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Metal fabrications, including welding, shop and field weld WPSs, PQRs, and fastener information.

Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

Submit source quality control data specified herein.

Samples: Color samples of abrasive stair nosings.

Submittals–Approval Not Required

Information/Record (IR):

Concrete and Masonry Drilled Anchors:

Manufacturer's product description and installation procedures.

ICBO evaluation report.

Adhesive Anchor Installer Certification.

Welding:

WPSs and WPQs.

CWI credentials and CWI reports.

Welding documentation.

U-Channel Concrete Inserts:

Manufacturer's product description.

Allowable load tables.

Ladders:

Certification of load and fatigue tests.

Passivation method for stainless steel members.

Documentation of construction quality control inspections specified herein.

Qualifications

Adhesive Anchor Installers: Trained and certified by manufacturer.

Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

Welding: WPSs and WPQs in accordance with AWS D1.1.

Delivery, Storage, and Handling

Insofar as practical, factory assemble items specified herein. Assemblies that due to necessity have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

Package stainless steel items in a manner to provide protection from carbon impregnation.

Protect painted coatings and hot-dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

Store fabricated items in dry area, not in direct contact with ground.

Part 2 – Products

General

Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Shapes and Plates	A36/A36M or A992
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Structural Steel Tubing	A500, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316
Shapes	A276, AISI Type 304
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 55, with weldability supplement S1
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	

Item	ASTM Reference
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48, Class 35

Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in FASTENER SCHEDULE at end of this section.

Anchor Bolts and Anchor Bolt Sleeves

Cast-In-Place Anchor Bolts: Headed type, unless otherwise shown on Drawings.

Material type and protective coating as shown in FASTENER SCHEDULE at end of this section.

Anchor Bolt Sleeves:

Plastic:

- Single unit construction with corrugated sleeve.
- Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.

Material: High density polyethylene.

Manufacturer: Sinco Products, Inc., Middletown, CT. (800-243-6753).

Fabricated Steel: ASTM A36/A36M.

Concrete Drilled Anchors

General

- AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in FASTENER SCHEDULE at end of this section.
- Current evaluation and acceptance reports by ICBO.

Wedge Anchors:

Manufacturers and Products:

- ITW Ramset/Red Head, Wood Dale, IL; Trubolt Wedge Anchor.
- Hilti, Inc., Tulsa, OK; Kwik-Bolt II Stud Anchor.
- Powers Rawl, New Rochelle, NY; Power-Stud Anchor.
- Simpson Strong-Tie Co., Inc., Pleasanton, CA; Wedge-All Anchor.
- Wej-It Corp., Tulsa, OK; ANKRtite Wedge Anchor.
- U.S. Anchor, Pompano Beach, FL; Kingpin Wedge Anchor.

Expansion Anchors: Self-drilling anchors, snap-off or flush type, zinc-plated.

Nondrilling Anchors: Flush type for use with zinc-plated or stainless steel bolt, or stud type with projecting threaded stud.

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Multi-Set II Drop-In and Self Drill Anchor.

Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.

Powers Rawl, New Rochelle, NY; Steel Drop-In Anchor.

Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.

Sleeve Anchors:

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Dynabolt Hex Nut Sleeve Anchor.

Powers Rawl, New Rochelle, NY; Hex Head Power-Bolt Anchor.

Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.

Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.

Adhesive Anchors:

Threaded Rod:

ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.

Length as required, to provide minimum depth of embedment.

Clean and free of grease, oil, or other deleterious material.

Adhesive:

Two-component, designed to be used in adverse freeze/thaw environments, with gray color after mixing.

Cure Temperature, Pot Life, and Workability:

Compatible for intended use and environmental conditions.

Nonsag, with selected viscosity base on installation temperature and overhead application where applicable.

Packaging and Storage:

Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.

Store adhesive cartridges on pallets or shelving in covered storage area, in accordance with manufacturer's written instructions.

Cartridge Markings:

Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.

Dispose of cartridges if shelf life has expired.

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Epcon Ceramic 6 Epoxy or A7 Adhesive Anchor System.

Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT HY 150 (HIT HY 20 for hollow masonry).

Powers Rawl, New Rochelle, NY; Power Fast Epoxy Injection Gel Cartridge System.

Simpson Strong-Tie Co., Inc., Pleasanton, CA; Epoxy-Tie Adhesive ET or Acrylic-Tie Adhesive. (Use only Acrylic-Tie Adhesive for temperatures below 40 degrees F.)

Covert Operations, Inc., Long Beach, CA; CIA-Gel 7000 Epoxy Anchors.

U.S. Anchor, Pompano Beach, FL; Ultrabond 1.

Unitex, Kansas City, MO; Pro-Poxy 300 and Pro-Poxy 300 Fast Epoxy Adhesive Anchors.

Diversified Fastening Systems of America, Charles City, Iowa; DFS Wedge Anchors.

Adhesive Threaded Inserts: Stainless steel, internally threaded insert.

Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-R Insert with HIT HY 150 adhesive.

Welded Anchor Studs

Headed anchor studs (HAS) or threaded anchor studs (TAS), as indicated on Drawings.

Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.

Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

Manufacturers:

Nelson Stud Welding, FabriSteel Co., Elyria, OH.

Stud Welding Associates, Inc., Elyria, OH.

Embedded Steel Support Frames For Floor Plate And Grating

Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

Welded anchors for stainless steel support frames shall also be stainless steel.

Abrasive Nosing For Stairs

Unless otherwise shown on Drawings, furnish flush type abrasive nosing on stairs.

Nosing Components:

Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.

Epoxy abrasive shall extend over and form curved front edge of nosing.

Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

Size: 3 inches wide by 1/4 to 3/8 inch thick by length as shown.

Color: Selected by Tank Farm Contractor from manufacturer's standard color range.

Manufacturers and Products:

Wooster Products, Inc., Wooster, OH; Spectra Type WP3C.

American Safety Tread Co., Inc., Helena, AL; Type FA-311D.

Fabrication

General:

Fabricate as shown and in accordance with AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.

Finish exposed surfaces smooth, sharp, and to well-defined lines.

Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.

Fit and assemble in largest practical sections for delivery to site.

Materials:

Use steel shapes, unless otherwise noted.

Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.

Welding:

Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.

Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.

Steel: Meet fabrication requirements of AWS D1.1, Section 5.

Stainless Steel: Meet requirements of AWS D1.6.

Welded Anchor Studs:

Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1, Section 7, and manufacturer's instructions.

Complete welding before applying finish.

Painting:

Coat all fabricated carbon steel as specified in Section 09900, PAINT COATING SYSTEMS, unless otherwise indicated.

Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs and stainless steel anchor bolts, unless indicated otherwise.

Galvanizing:

Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.

Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385.

Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.

Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.

Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.

Galvanized steel sheets in accordance with ASTM A653.

Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

Source Quality Control

Visually inspect all fabrication welds and correct any deficiencies.

Steel: AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

Stainless Steel: AWS D1.6.

Welded Anchor Studs: AWS D1.1 or AWS D1.6 as applicable.

Part 3 – Execution

Installation Of Metal Fabrications

General

Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.

Install rigid, substantial, and neat in appearance.

Install manufactured products in accordance with manufacturer's recommendations.

Obtain Construction Manager approval prior to field cutting steel members or making adjustments not scheduled.

Cast-In-Place Anchor Bolts

Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

Concrete and Masonry Drilled Anchors

Begin installation only after concrete or masonry to receive anchors has attained design strength.

Install in accordance with manufacturer's instructions.

Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Min. Embedment (bolt diameters)	Min. Edge Distance (bolt diameters)	Min. Spacing (bolt diameters)
Wedge	9	6	12
Expansion and Sleeve	4	6	12
Adhesive	9	9	13.5

Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air.

When embedded steel or rebar is encountered in the drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Construction Manager for direction on how to proceed.

Adhesive Anchors:

Do not install adhesive anchors when temperature of concrete is below 40 degrees F (25 degrees F for Simpson Strong-Tie Acrylic-Tie Adhesive) or above 100 degrees F.

Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry where required by manufacturer's instructions.

Do not disturb anchor during recommended curing time.

Do not exceed maximum torque as specified in manufacturer's instructions.

Electrolytic Protection

Aluminum and Galvanized Steel:

Coat surfaces of galvanized steel fabricated and aluminum items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, PAINT COATING SYSTEMS, unless indicated otherwise.

Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

Allow coating to dry before installation of the material.

Protect coated surfaces during installation.

Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

Stainless Steel:

During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.

After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.

Remove contamination in accordance with requirements of ASTM A380 and A967.

Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

After treatment, visually inspect surfaces for compliance.

Repair Of Galvanized Steel

Conform to ASTM A780.

For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.

For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.

Use magnetic gauge to determine that thickness is equal to or greater than the base galvanized coating.

Fastener Schedule

Provide fasteners as follows:

Service Use and Location	Product	Remarks
Anchor Bolts Cast Into Concrete for Structural Steel Column Base Plates		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components		
Interior Dry Areas	Stainless steel headed anchor bolts	
Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Zinc-plated or stainless steel wedge or expansion anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members
Connections for Steel Fabrications		
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections	
All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

Antiseizing Lubricant: Use on all stainless steel threads.

Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

Construction Quality Control

Construction General Contractor shall inspect concrete drill anchor installation to verify compliance with anchor size, embedment, edge length, and spacing as specified herein and shown on the Drawings. Provide inspection documentation to Construction Manager.

END OF SECTION 05500

DIVISION 6–WOODS AND PLASTIC (NOT USED)

DIVISION 7–THERMAL AND MOISTURE PROTECTION

SECTION 07210 - BUILDING INSULATION SCHED. B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
ASTM C665	Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
ASTM D4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data: Submit product data indicating compliance with the requirements of this section.

Material Storage

Store off ground and keep dry at all times. Protect against weather condensation and damage.

Part 2 – Products

Materials

Mineral/Glass Fiber Blanket/Batt Insulation: ASTM C665, Type III, Class B, fiberglass batts with vinyl vapor retarder; R-30 for roof and R-19 for walls.

Rigid Insulation: ASTM C578, Type IV, extruded polystyrene; R-value as shown.

Vapor Retarder: ASTM D4397 plastic sheeting, 6 mils minimum.

Part 3 – Execution

Installation

Batt Insulation:

Install in accordance with the manufacturer's instructions.

Fasten flanges to the sides of framing members with the vapor retarder facing the warm side. Fit tightly to ensure a continuous seal.

Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on the cold weather side of the obstruction.

Provide fasteners, adhesive, tape, and sealant as recommended by insulation manufacturer.

Vapor Retarder:

Apply to inside face of exterior wall and ceiling framing in sheets as large as possible, lapping all joints 6 inches and sealing with sealant and tape recommended by manufacturer.

Fit tightly and seal around all penetrations.

Replace torn and punctured sheets.

Repair minor tears or holes with tape.

Repair by replacement major tears or holes that require more than a 6-inch length of tape to repair.

Rigid Insulation:

Install with fasteners or adhesive recommended by manufacturer.

Butt joints tightly together.

Where thicker than 2 inches, install in two layers, staggering all joints.

Cleanup and Protection

Remove from site all containers, wrappings, and scrap insulation material. Leave floors broom clean.

Protect installed insulation from tears or other damage until covered with finish material. Replace damaged material.

END OF SECTION 07210

1 **DIVISION 8–DOORS AND WINDOWS (NOT USED)**

DIVISION 9–FINISHES

SECTION 09900 - PAINT COATING SYSTEMS SCHED. A & B

Part 1 – General

References

The following documents and others referenced therein form part of Contract to the extent designated. Referenced documents are those current, unless otherwise indicated.

ASTM INTERNATIONAL (ASTM)

ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D570	Test Method for Water Absorption of Plastics
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D714	Test Method for Evaluating Degree of Blistering of Paints
ASTM D772	Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
ASTM D1653	Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D3912	Test Method for Chemical Resistance of Coatings Used in Light-Water Nuclear Power Plants
ASTM D4060	Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4082	Test Method for Effects of Gamma Radiation on Coatings for Use in Light-Water Nuclear Power Plants
ASTM D4259	Standard Practice for Abrading Concrete
ASTM D4263	Test Method for Indicating Moisture Content in Concrete by the Plastic Sheet Method
ASTM D4541	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5139	Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants
ASTM D5144	Guide for Use of Protective Coating Standards in Nuclear Power Plants
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP 3	Power Tool Cleaning

SSPC-SP 6 Commercial Blast Cleaning

Submittals –Approval Required

See Section 01300, SUBMITTALS, for submittal procedures

List of Materials: Before delivery, submit colors and location to be used and manufacturer catalog data sheets and charts showing adequate information to substantiate compliance to the requirements of this section.

Submittal shall also enumerate percentage of volatile and nonvolatile materials, percentage of component parts of each type of material, and the conversion factors to determine dry film thickness from applied wet film thickness. Also, submit Material Safety Data Sheets (MSDS) for materials proposed to be used.

Installer's Certificate (Decontaminable Coatings Only): Before application, submit documentation that the application crew has been certified by the coating system manufacturer as qualified to apply the selected coating system. As an alternative to crew certification, a submittal documenting onsite training by a technical representative from the coating manufacturer would be acceptable.

Cleaning and Disposal Plan: Before application, submit a plan for proper collection, storage, and disposal of all materials spotted or soaked with paint, oil, solvents, and other flammable waste materials. The plan shall also address handling and disposal of empty cans. The plan shall address both daily cleanup requirements and cleanup at the completion of the coatings application activities.

Submit documentation and test results from construction quality control testing specified herein.

Delivery, Storage, And Handling

Obtain inspection and acceptance by Tank Farm Contractor before opening containers or removing labels.

Project Conditions

Environment for Coating: Coat exterior surfaces only when ambient and surface temperatures are within the range recommended by the coating manufacturer for the respective coating, which is within 40 to 120 degrees F, and ambient temperature is a minimum of 5 degrees F above the dewpoint.

Part 2 – Products

Materials

Shop Primer for Carbon Steel Assemblies: Ameron-Amerlock 400.

Decontaminable Coatings for all Metal and Concrete: (Service Level II as defined in ASTM D5144)

Decontaminability: Evaluation of coating systems decontaminability as noted in ASTM D5144 Section 5.4, is difficult to quantify. To determine the coating systems decontamination properties, the coating system shall be tested for chemical resistance properties as addressed in this specification.

Radiation Tolerance: Coatings applied to the specified thickness shall demonstrate tolerance to a total accumulated dose in air of 6×10^7 Rads of gamma radiation in accordance with ASTM D4082. Test samples shall be prepared in accordance with ASTM D5139.

Physical Properties: Base and finish coatings shall have the physical property strengths shown in the tables below as determined by the respective test method.

For Rigid Decontaminable Coatings (High Solids Epoxies):

Test	Method	Results
Adhesion to Substrate	ASTM D4541	Steel-Minimum 900 psi Concrete-8% of concrete compressive strength
Elongation at break at 75°F		Minimum 5%
Water Absorption or	ASTM D570 (24 hr)	Maximum 0.5%
Moisture Vapor Transmission	ASTM D1653	Maximum 8 gm/m^2
Wear Resistance (Finish or lost Top Coat Only)	ASTM D4060, 1,000 cycles, 1,000 g weight, CS-17 wheel	Less than 175 mg

Chemical Resistance: The coating system shall be resistant to the standard decontamination solutions listed in ASTM D3912, Figure 1. Chemical resistance testing shall be in accordance with ASTM D3912, or an equivalent standard, for occasional splash and spillage service, except test samples shall be prepared in accordance with ASTM D5139. Submit manufacturer's chemical resistance test plan, including procedure for exposing coating samples for evaluating occasional splash and spillage conditions, for evaluation and approval. Criteria for acceptance shall be based on the following:

Flaking: As evaluated in accordance with ASTM D772, flaking and peeling shall not be permitted

Blistering:

As evaluated in accordance with ASTM D714, blisters shall be limited to size 4, 6, or 8, and a frequency no more than a "few."

Delamination will not be permitted.

Slight discoloration will be permitted.

Coating shall be volatile organic content (VOC) compliant with a maximum VOC of 2.9 lbs/gal.

Fire Characteristics:

Coatings used shall not develop significant qualities of toxic or other harmful products of combustion when exposed to fire. Coatings shall have a UL (ASTM E84/NFPA 255*)* flame spread rating of 25 or less and smoke developed rating of 50 or less.

Coatings shall be repairable for cracks appearing through the applied-coated surface to the substrate and for chips and flaking due to mechanical damage.

Coating shall have a design life of 12 years. In addition to radiation tolerance requirements, coating shall be resistant to humidity ranging from 0 to 100 percent and an ambient air temperature range of 120 degrees F to minus 32 degrees F, with a maximum 24-hour differential of 52 degrees F.

Primers, thinners, and coating accessory materials shall be produced or approved for use by the same manufacturer as the finish coating system.

Decontaminable Coating Systems (Epoxies), or Approved Substitute:

Manufacturer Product	Ameron
Steel and Concrete Primer	Amerlock 400
Concrete Surfacer	Nu-Klad 114A
Base Coating	Amerlock 400
Intermediate and Finish Coating	PSX 700 Siloxane

Joint Sealant: "Nu-Klad 750A/760A" by Ameron, or approved substitutes, shall be used.

Scrim Cloth: Glass fiber reinforcing fabric as recommended by coating system manufacturer.

Part 3 – Execution

Examination

Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, performance, or quality of work, and that cannot be put into acceptable condition through preparatory work.

Report conditions that could adversely affect proper application of coatings, in writing, to Construction Manager. Do not begin surface preparation or coating application until defects have been corrected and conditions have been made suitable.

Preparation

Before application, remove as much dust and debris as possible from space or area to receive coating to allow for proper installation.

Pre-Priming:

Ferrous Metal and Carbon Steel:

Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

Prepare shop assemblies in accordance with SSPC-SP 6. Remove abrasive residue and dust, and prime within 4 hours after preparation. Apply minimum of 3.0 mil of shop primer in accordance with manufacturer's recommendations.

Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.

Prepare field erections in accordance with SSPC-SP 3 or SSPC-SP 6. Remove abrasive residue and dust.

Surface Preparation:

Shop and field surface cleaning and surface preparation requirements for all substrates shall be in accordance with the manufacturer's written instructions and these Specifications. Where the specified degree of surface preparation differs from the manufacturer's recommendations, the more stringent shall apply.

Concrete shall be at least 30 days old before coating is applied.

Prior to application of coating system or surfacer to new concrete surfaces, perform a plastic sheet test in accordance with ASTM D4263. The test shall be initiated in the afternoon and completed the following morning. The absence of condensation on the test sheet shall indicate the concrete is ready to have the coating system applied. Document test results.

Clean new concrete surfaces to be coated by Abrasive Blast Cleaning Procedures in accordance with ASTM D4259.

Prepare or repair construction joints, shrinkage cracks, and other non-expanding cracks, gaps, or crevices in the surface to be coated, in accordance with coating manufacturer's recommendations. Scratches, cracks, holes, pinholes, and abrasions shall be cut back to proper key and filled with surfacer.

Post-Priming: Feather abrasions, chips, skips, and holidays occurring in prime coat by sanding, and recoat with material and color to minimum dry film thickness specified.

Previously coated surfaces shall be recoated only after existing film is completely dry. Some coating systems require the application of succeeding coats within a set time frame for it to properly adhere to the previous coat. Should the time frame recommended by the coating manufacturer be exceeded, prepare the base coat as recommended by the coating manufacturer.

Protection:

Provide and install drop cloths, shields, and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings, and over-run of coating materials to a minimum and remove as coating work progresses.

Protect coating from rain until dry to touch.

Upon completion of each coating application, protect coated surfaces from physical damage or chemical contamination.

Application

Apply coating materials in accordance with manufacturer's recommendations.

Apply with equipment recommended by coating manufacturer.

Number of Coats, Film Thickness:

Apply the minimum number of coats specified without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

Maximum film build per coat shall not exceed coating manufacturer's recommendations.

Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thickness is likely to be present, and ensure proper millage in these areas.

Sealant Application:

Rigid Coating Systems:

After pre-primer is installed (see Article COAT SCHEDULE), apply sealant to expansion joints at the coated surface boundary. Mask limits of joint to provide a neat appearance. Roughen contact surfaces with sandpaper. Prime and install sealant in accordance with manufacturer's instructions.

Identify each coat of opaque material by its relation to color of finish coat. Prime coat shall be darkest tint of specified color with each succeeding coat lighter, up to finish coat, which shall be color, tint, and sheen specified in Article COAT SCHEDULE or as shown on the Drawings. Tints of identical coats of identical color and material shall not vary.

Recoat and repair as necessary for compliance with the Specifications.

Cleaning

Collect and dispose of materials spotted or soaked with paint, oil, or solvents, and other flammable waste materials daily in accordance with the coating manufacturer's recommendations. Minimize volume of potentially contaminated solids and liquids that must be disposed.

Salvageable brushes, rollers, spatulas, and spray equipment shall be thoroughly cleaned after use and shall contain no oils, thinners, or other residue after cleaning.

Dispose of empty cans at end of each shift in accordance with the cleaning and disposal plan.

At completion of coating work, remove and dispose of materials, containers, rags, cloths, brushes, equipment, and miscellaneous other debris in accordance with the cleaning and disposal plan.

Clean up spills and report, if required, in accordance with the cleaning and disposal plan.

Construction Quality Control

The Construction General Contractor shall perform the field tests specified herein with properly calibrated instruments. All testing shall be performed and recorded by personnel trained in the use of the test instruments.

Thickness Testing:

Measure coating thickness on steel with a properly calibrated, magnetic type dry film thickness gauge (as manufactured by Nordson; or approved equal).

Measure the wet film thickness (WFT) of each coat of material with a notched WFT gage (Nordson 790-015*)* at a minimum of five evenly spaced points for each 100 square feet of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness.

Adhesion Testing:

Adhesion testing is required where the specified decontaminable coatings system is applied to concrete.

Perform adhesion testing at each field or shop location where surfaces are prepared and coatings are applied.

After surface preparation and coating application procedures have been observed and approved by the paint manufacturer's representative, select one representative location for an adhesion pull test. If the adhesion pull test does not meet the specified requirement, perform additional pull tests to determine the area of inadequate adhesion. Remove and replace coatings with inadequate adhesion.

If changes are observed in the shop or field application procedures that may affect coating adhesion, Construction Manager may require additional adhesion tests.

Construction General Contractor shall provide all test equipment required for adhesion testing.

Repair all coatings damaged by adhesion testing in accordance with the coating manufacturer's directions.

Inspection: Perform tests to ascertain that coating materials have been applied as specified in this section. Document test results. Document surface preparation, application of all coats of material, and performance of wet and dry film thickness testing in accordance with this section.

Perform water tightness test of concrete sumps in accordance with Component Construction Acceptance Test as provided in the Construction Inspection Plan, RPP-18490, Rev. 0.

Application Schedule

Concrete: Coat exposed concrete surfaces of building slabs, truck loading slab, sump, and other concrete surfaces as shown on the Drawings.

Carbon Steel:

Coat all exposed carbon steel with the coating system specified in Article COATING SCHEDULE.

Coat concrete embedded anchor bolts and concrete embedded structural steel with carbon steel coating system, except delete intermediate and finish coats. Repair coating on anchor bolt threads after nuts are installed in accordance with manufacturer's recommendations.

See Section 13122, METAL BUILDING SYSTEMS, for painting requirements associated with prefabricated steel buildings and Section 13205, LINED BOLTED STEEL LIQUID STORAGE TANKS, for painting requirements associated with the bolted steel tank.

Aluminum and Galvanized Steel in Contact with Concrete: Coat aluminum and galvanized steel in contact with concrete with carbon steel coating system, primer only. Provide a minimum dry film thickness of 4 mils.

Coat Schedule

Coat	Description	Color (*see Note 1)	Minimum Dry Film µm (mils)
Concrete – Rigid Coating System (Epoxies):			
Pre-Prime	Amerlock 400-thinned approx. 20-25% with #65 thinner.	N/A	Enough to seal surface
Joint Sealer	NuKlad 760A	N/A	N/A
Surfacer	NuKlad 114A	N/A	As required to fill voids

Prime and Base	Amerlock 400	*	Two coats: Prime 75 (3.0) Base 100 (4.0)
	PSX 700 Siloxane	*	
Intermediate and Finish. Between coats wipe entire surface with clean thinner #65, #12, or equal.			Two coats: Intermediate 100 (4.0) Finish 100 (4.0) (See Note 2)
Vitrogrit crushed glass abrasive	#29 Round Mesh (See Note 7)		
Carbon Steel:			
Shop and Field Primer	Amerlock 400, see Note 3	*	75 (3.0)
Base	Amerlock 400, see Note 3	*	100 (4.0)
Intermediate	See Note 4 PSX 700 Siloxane	*	100 (4.0)
Finish	PSX 700 Siloxane		100 (4.0)
PVC (exterior UV exposed):			
Finish	Carbocrylic 3359 DTM (See notes 5 and 6)		100 (4.0)

Notes:

1. Contrast each coat from primer-darker to finish-lighter. Finish coat to be off-white to white, except bollards, truck loading connection piping support, and manhole lids, which shall be yellow.
2. Verify recoating times between intermediate and finish coats with the coating manufacturer if relative humidity is less than 40 percent.
3. Prime and base coats may be applied in single 180 µm coat if base coat is self-priming.
4. For anchor bolts, delete intermediate and finish coats.
5. Prepare PVC by hand tool cleaning (scuff sand) using minimum 80 grit sandpaper in all directions.

~~6. For PVC associated with stilling wells at leachate tanks, coat only PVC exposed to UV above tank floating cover.~~

~~7.~~ 6. For the Truck Loading concrete pad, apply #29 round mesh VitroGrit crushed glass abrasive in between the intermediate and final coat in accordance with manufacturer's recommendation. After the intermediate coat is applied spread the sand in excess over the wet surface and let dry. After the surface has dried, sweep or vacuum the excess sand and apply the final coat.

END OF SECTION 09900

DIVISION 10–SPECIALTIES (NOT USED)

DIVISION 11–EQUIPMENT

SECTION 11305 - COMBINED AND BUILDING SUMP PUMPS SCHED. B

Part 1 – General

References

The following is a list of standards that may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI).

ASTM INTERNATIONAL (ASTM)

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

HYDRAULIC INSTITUTE STANDARDS (HIS)

NATIONAL ELECTRIC CODE (NEC)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electric Code

UNDERWRITERS LABORATORIES INC. (UL)

Definitions

Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, from motor manufacturer.

Functional testing plan demonstrating compliance with requirements specified herein.

Submittals–Approval Not Required

Information/Record (IR): Results of construction quality control testing.

Vendor Information (VI):

Manufacturer's printed installation instructions, operations, and maintenance data, including preventative maintenance tasks and frequencies for performance of those tasks.

Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

Factory finish system.

Extra Materials

Furnish for each pump: One set mechanical seals.

Part 2 – Products

Supplements

Specific requirements are attached to this section as supplements.

Components

Pump equipment shall consist of pump(s) complete with motor(s), anchoring brackets, power cable(s), and pump lifting cable(s).

Lifting Arrangement: 2 feet minimum, stainless steel chain, and one "grip-eye". Attach chain permanently to pump and access platform with stainless steel wire rope. "Grip-eye" will be capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with "grip-eye" and independent hoist.

Components – Typical:

Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti-leak seal and shall be easily accessible from outside.

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cable shall be of sufficient length to reach junction boxes without strain or splicing.

Cable Entry System:

Junction chamber and motor shall be separated by stator lead sealing gland or terminal board that shall prevent foreign material entering through pump top.

Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.

O-ring compression seal between sealing gland and cable entry point shall also be acceptable.

Accessories

Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

Lifting Lugs: Equipment weighing over 100 pounds.

Factory Finishing

Manufacturer's standard enamel finish.

Part 3 – Execution

Installation

Install in accordance with manufacturer's printed instructions.

Connect suction and discharge piping without imposing strain to pump flanges.

Construction Quality Control

Construction General Contractor shall perform functional testing in accordance with approved test plan. Functional testing shall be performed in presence of Construction Manager or representative designated by the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Functional Test: Conduct on each pump.

Flow Output: Measured by plant instrumentation and/or storage volumes.

Amp Draw:

Verify motor current agrees with motor nameplate.

Test for continuous 30-minute period.

Supplements

The supplements listed below, following "END OF SECTION", are part of this Specification.

Sump Pump Data Sheet, 11305-01.

Sump Pump Data Sheet, 11305-02.

END OF SECTION 11305

Sump Pump Data Sheet, 11305-01

Tag Numbers: 219A-LH-P-207, 219E-LH-P-207

Pump Locations and I.D.: Buildings 219A and 219E, Combined Sump Pump

Manufacturer and Model Number: (1) Hydromatic Pump Co., Model SB3S
(2) Barnes
(3) Or approved equal

Service Conditions

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste disposal facility and rain/snow melt

Pumping Temperature (Fahrenheit): Normal: 55 Max: 130 Min: 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5.0-9.3

Abrasive (Y/N) (fine/coarse soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) 0.5

Performance Requirements

Capacity (US gpm): Rated: 250

Total Dynamic Head (Ft): Rated: 19

Maximum Shutoff Pressure (Ft): 50

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 50

Max. Pump Speed at Rated Capacity (rpm): 1,750

Constant (Y/N): Y Adjustable (Y/N): N

Design And Materials

Pump Type: Heavy-Duty Nonclog (Y/N) Y

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

Induction Drive Motor

Horsepower: 0.30 Voltage: 460 Phase: 3 Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N): N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Explosion-proof, submersible, Class 1, Div. 1 or Div. 2, Groups C and D

Sump Pump Data Sheet, 11305-02

Tag Numbers: 219A-LH-P-205, 219E-LH-P-205

Pump Locations and I.D.: Buildings 219A and 219E, Floor Sump

Manufacturer and Model Number: (1) Hydromatic Pump Co.

(2) Barnes

Service Conditions

Liquid Pumped: Leachate from low-level radioactive waste disposal facility

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5-9.3

Abrasive (Y/N) Y (fine/coarse soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) 0.5

Performance Requirements

Capacity (US gpm): Rated: 28

Total Dynamic Head (Ft): Rated: 14

Maximum Shutoff Pressure (Ft): 30

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 45

Max. Pump Speed at Rated Capacity (rpm): 1,750

Constant (Y/N): _____ (Y/N): _____

Design And Materials

Pump Type: Heavy-Duty Nonclog (Y/N) Y

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

Induction Drive Motor

Horsepower: 0.30 Voltage: 460 Phase: 3 Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N): N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

SECTION 11306 - LEACHATE PUMPS SCHED. B

Part 1 – General

General

Provide multi-stage, centrifugal, submersible pumps specifically designed for landfills and sideslope installations. Pumps shall be designed for pumping contaminated water and leachate. Provide all necessary pump appurtenances including lifting cable for lowering and removing the pump, power cable, a minimum 4-wheel system at each end of the pump specifically designed for transporting the pump in HDPE butt-fused carrier pipe, outlet pipe attachments and flex hose as necessary, and all other fittings or accessories required for a complete and fully functional installation.

The pump and all associated appurtenances shall be designed by the pump manufacturer to operate as a fully functional and reliable pump system. Provide a pump system capable of operating unattended with a high degree of reliability with multiple cycles per day.

Provide vent valve system, if necessary, to purge air from pumps to prevent pump air lock. Vacuum air release valves are provided in system piping at top of riser.

Provide quick-couple fitting at end of pump where outlet pipe attaches.

Remove pump discharge check valve or drill hole in check valve to prevent water from accumulating above pump outlet. Pump shall be fully capable of operating with check valve removed.

Provide stainless steel tag numbers and mounting fasteners and engrave with the equipment tag number and model number for each pump.

Note that pump control will be accomplished through software programming and the PLC mounted in the system control panels (by others) located in each Crest Pad Building.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Functional testing plan demonstrating compliance with requirements specified herein.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Detailed catalog information, descriptive literature, and specifications of all components associated with pump removal system.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

Submittals–Approval Not Required

Information/Record (IR):

Manufacturer's certification of factory testing to establish conformance with specified requirements. Certification must include certificates of calibration traceable to a nationally recognized standards organization such as National Institute of Standards and Technology (NIST).

Special shipping, storage and protection, and handling instructions.

Manufacturer's Certificate of Proper Installation.

Results of field quality control testing.

Vendor Information (VI):

Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Operation and maintenance manual.

Part 2 – Products

Pumps

All major components shall be Type 304 stainless steel including the housing, fasteners, shaft, diffuser chamber, and impeller(s). Components shall be highly corrosion resistant and suitable for contaminated water and leachate service. Gaskets, O-rings, and seals shall have compatibility properties equivalent to Viton material as a minimum.

Pump bearings shall have better heat and wear resistance than Teflon bearings.

Provide power and stainless steel cable as recommended by manufacturer and to the length and configuration as shown on the Drawings.

Motors

Provide sealed pump motors suitable for continuous submerged service. Provide continuous motor leads without splices along the full length of the discharge pipe. Leads shall be fully insulated with chemical and waterproof insulation properties. Provide motor designed for continuous duty and multiple cycle times of 60 starts per hour. Motors shall have thermal overload protection.

Source Quality Control

Construction General Contractor shall perform source quality testing at the factory as specified herein. Notify Construction Manager in writing at least 10 days in advance of testing. Construction Manager will coordinate with personnel required to witness testing.

Factory Tests and Adjustments: Test all equipment actually furnished.

Factory Test Report: Include test data sheets, curve test results, performance test logs.

Performance Test

Conduct on each pump.

Perform under simulated operating conditions, at a minimum of six operating points on the pump curve.

Test for a continuous 30-minute period without malfunction. Check for excessive or abnormal vibrations and correct deficiencies.

Test Log: Record the following:

Total head.

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Adjust or modify units and retest if necessary.

Pump Removal System:

Provide one common manual pump removal winch and winch support for raising and lowering the LCRS low flow and secondary leak detection pump and associated discharge piping. Provide one manual pump removal winch and winch support for raising and lowering the high flow pump and associated discharge piping. Winches shall be brake (spur gear) winch with automatic brake: Thern Model No. 4032PB (low flow/secondary leak detection) and M452B (high flow), or equal. Provide winch with sufficient capacity to handle required length of lifting cable (stainless steel wire rope). Lifting cable shall include and the winch accommodate a swage ball fitting cable end for quick connect/disconnect.

Winch shall be mounted on structural steel support. The winch support shall only be installed for pump installation/removal. Three sets of drop-in anchors shall be installed in floor that match the winch support base bolt pattern. Each set of drop-in anchors shall be located to align the winch support with each HDPE riser pipe such that the lifting cable does not rub the HDPE riser pipe during pump installation/removal. Coordinate location of the drop-in anchors with Construction Manager.

Provide two manual hose reels for separately handling the leachate pump power and level transducer cables. Hose reels shall be heavy-duty hand crank reels with adjustable spool rotation drag and spool lock pins. Hose reels shall be Reelcraft Model No. C33118LI, or equal. Each reel shall be located as required for proper alignment with appropriate riser pipe. Drop-in anchors shall be installed in floor that match hose reel "feet" bolt pattern for both reels. Bolts shall be left in place to prevent accumulation of dirt, etc., in anchor threads. Bolts shall be tapered flathead to eliminate tripping hazard.

Level Sensors:

Provide level sensors integral to Cell 1 and Cell 2 LDS leachate pump (two total) as shown on the Drawings. Level elements shall be designed and constructed for landfill leachate service, i.e., fully submersible and chemically resistant.

The level sensor shall include a transmitter with built-in temperature compensation and an accuracy of plus or minus 1.0 percent. Sensor output shall be a conditioned compensated 4 to 20 mA signal.

The sensor control cable shall be shielded to prevent signal disruption and include a vent tube for atmospheric pressure compensation. Control cables shall include polyurethane jacket and Kevlar tension members.

Level sensors shall be mounted on the pump housing and be field serviceable without having to disassemble the pump.

Part 3 – Execution

Installation

Install in accordance with manufacturers' printed instructions and manufacturers' representatives' guidance and recommendations.

Construction Quality Control

Construction General Contractor shall perform functional testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Function Tests:

Prior to the pump and level transducer insertion tests identified in the Component CAT procedures, verify the LCRS, LDS, and SLDS riser pipe transition from the side slope to the horizontal portion of the riser pipe is adequate for leachate pump and level transducer insertion. Perform the pump/level transducer insertion tests prior to backfilling and after the riser pipe installation is finished from within the sump to a location approximately 50 feet up the side slope. Perform the pump/level transducer insertion tests using the associated leachate pump or level transducer for each riser. In addition to the level transducer insertion for the SLDS riser pipe, test the transition using the LDS low-flow leachate pump as well. If actual level transducers or leachate pumps are not available at the time of the testing, "dummy" level transducers and pumps can be used per approval from CHG Construction Manager.

After complete installation of the side slope riser pipe from the sump to the crest pad building, verify exact length of pump discharge and level transducer piping required by using a long tape measure to measure actual dimension. Test the insertion and extraction of each pump from the side slope riser pipe and into the crest pad buildings. Perform testing while the perforated carrier pipe sections in the sumps are exposed to allow observation of the pump removals and insertions from the carrier pipe.

Test the pumps under simulated conditions using a temporary tank located at the bottom of the landfill. Place pump in the tank and connect temporary flexible hose between the pump and discharge pipe routed up the side slope surface and between the discharge pipe and riser connection in Crest Pad Building. Keep the tank full to supply adequate water to the pumps during the pump test. Record amp draw readings.

Supplements

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Data Sheets:

Supplement 1—Leachate Pump Data Sheet, 11306-01.

Supplement 2—Leachate Pump Data Sheet, 11306-02.

Supplement 3—Leachate Pump Data Sheet, 11306-03.

Supplement 4—Leachate Pump Data Sheet, 11306-04.

END OF SECTION 11306

Leachate Pump Data Sheet, 11306-01

Tag Numbers: 219A-LH-P-202, 219E-LH-P-202

Pump Locations and I.D.: Cell 1 LCRS Sump, Low Flow

Cell 2 LCRS Sump, Low Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 3-3

(2) Or equal

Service Conditions

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

Performance Requirements At Primary Design Point

Capacity (US gpm): Rated: 13

Total Dynamic Head (Ft): Rated: 66

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 90

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

Design And Materials

Design: Wheeled enclosure frame   Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA   Material: NA

Impeller: Type: Closed   Material: Type 304 SST

Impeller Wear Ring (Y/N): Y   Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST   Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y   Ring Material: E-Glide or equal   Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA   Lubrication: NA

Drive Type: Direct Coupled

Induction Drive Motor

Horsepower: 0.5   Voltage: 460   Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15   Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-02

Tag Numbers: 219A-LH-P-203, 219E-LH-P-203

Pump Location and I.D.: Cell 1 LCRS Sump, High Flow

Cell 2 LCRS Sump, High Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 30-4

(2) Or equal

Service Conditions

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

Performance Requirements At Primary Design Point

Capacity (US gpm): Rated: 155

Total Dynamic Head (Ft): Rated: 118

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 208

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

Design and Materials

Design: Wheeled enclosure frame (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic), or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide (engineered plastic), or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

Induction Drive Motor

Horsepower: 7.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-03

Tag Numbers: 219A-LH-P-204, 219E-LH-P-204

Pump Locations and I.D.: Cell 1 LDS Sump

Cell 2 LDS Sump

Manufacturer and Model Number: (1) EPG Companies; Model WSD 1.5-3

(2) Or equal

Service Conditions

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

Performance Requirements At Primary Design Point

Capacity (US gpm): Rated: 4

Total Dynamic Head (Ft): Rated: 65

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 80

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

Design And Materials

Design: Wheeled enclosure frame Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

Induction Drive Motor

Horsepower: 0.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-04

Tag Numbers: 219-LH-P-208

Pump Locations and I.D.: Cell 1 SLDS Sump

Cell 2 SLDS Sump

Manufacturer and Model Number: (1) EPG Companies; Model WSD 1.5-4

(2) Or equal

Service Conditions

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

Performance Requirements At Primary Design Point

Capacity (US gpm): Rated: 4

Total Dynamic Head (Ft): Rated: 65

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 80

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

Design and Materials

Design: Wheeled enclosure frame Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

Induction Drive Motor

Horsepower: 0.5 Voltage: 120 Phase: 1

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Note: An adequate length of power cord shall be supplied. Standard plug shall be provided on the power cord.

SECTION 11312 - HORIZONTAL END SUCTION CENTRIFUGAL PUMPS SCHED. B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

AMERICAN BEARING MANUFACTURERS' ASSOCIATION (ABMA)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Type 416	Stainless Steel
Type 1035	Steel
Type 1045	Carbon Steel
Type 4140	Alloy Steel

ASTM INTERNATIONAL (ASTM)

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE STANDARDS

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	Motors and Generators

Definitions

Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Functional testing plan demonstrating compliance with requirements specified herein.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

Submittals–Approval Not Required

Information/Record (IR):

Special shipping, storage and protection, and handling instructions.

Manufacturer's Certificate of Proper Installation.

Results of field quality control testing.

Vendor Information (VI):

Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions.

Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Factory finish system data sheets.

Extra Materials

Furnish for each pump:

Complete set packing.

Complete set bearings.

Complete set gaskets and O-ring seals.

Complete set of shaft sleeves.

Complete set keys, dowels, pins, etc.

Complete mechanical seal.

Impeller.

Impeller shaft.

Impeller wear ring.

Head shaft.

One complete set of any special tools required to dismantle pump.

Part 2 – Products

General

Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

Supplements

Some specific requirements are attached to this section as supplements.

Accessories

Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

Lifting Lugs: Equipment weighing over 100 pounds.

Anchor Bolts: Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

Factory Finishing

Manufacturer's standard enamel finish.

Source Quality Control

Construction General Contractor shall perform source quality control testing at the factory as specified herein. Notify Construction Manager at least 10 days in advance of testing.

Performance Test: Perform manufacturer's standard motor test on equipment.

Part 3 – Execution

Installation

Install in accordance with manufacturer's printed instructions.

Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout. Remove wedges after grout is set and pack void with grout.

Connect suction and discharge piping without imposing strain to pump flanges.

Anchor Bolts: Accurately place using equipment templates and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

Construction Quality Control

Construction General Contractor shall perform field quality control testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Functional Tests:

Conduct on each pump.

Test for a continuous 1/2-hour period without malfunction.

Test Log: Record the following:

Total head.

Capacity.

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

Manufacturer’s Services

Manufacturer’s Representative: Present at site or classroom designated by Tank Farm Contractor, for minimum person-days listed below, travel time excluded:

Person-day for installation assistance and inspection.

Person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.

Supplements

The supplements listed below, following “END OF SECTION,” are a part of this Specification.

Pump Data Sheet, 11312-01

END OF SECTION 11312

Horizontal End Suction Centrifugal Pump Data Sheet, 11312-01

Tag Numbers: ______________________________

Pump Name: ______________________________

Manufacturer and Model Number: (1) ______________________________

(2) ______________________________

Service Conditions

Liquid Pumped (Material and Percent): ______________________________

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5.0-9.3

Abrasive (Y/N) Y (fine soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) .25

Performance Requirements At Primary Design Point

Capacity (US gpm): Rated: 250

Total Dynamic Head (Ft): Rated: 25

Min. Hydraulic Efficiency (%): 75

Maximum Shutoff Pressure (Ft): 40

Max. Pump Speed at Design Point (rpm): 1,750

Constant (Y/N): Y Adjustable (Y/N): N

Design And Materials

ANSI (Y/N) Y Standard (Y/N) Y Design: Frame-mounted (Y/N) Y

Close-Coupled Casing (Y/N) N Back Pullout (Y/N) Y

Discharge Orientation: 12:00 Rotation (view from end coupling): CW

Shaft Seal: Packing (Y/N) N

Mechanical (Y/N) _____

Lubrication: Process Water

Drive Type: Direct-Coupled: _____ Belt _____ Adjustable Speed _____

Induction Drive Motor

Horsepower: _____ Voltage: _____ Phase: _____ Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N) _____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Totally enclosed fan cooled

Mounting Type: Horizontal _____ Nonreverse Ratchet (Y/N) _____

Testing

Pump Tests: Factory Functional (Y/N) _____ Field Performance (Y/N) N

Factory Hydrostatic Casing Pressure Test (Y/N) _____

Field Functional (Y/N) _____ Field Performance (Y/N) _____

Field Vibration (Y/N) N

DIVISION 12–FURNISHINGS (NOT USED)

DIVISION 13–SPECIAL CONSTRUCTION

SECTION 13122 - METAL BUILDING SYSTEMS SCHED. B

Part 1 – General

Work Included

The Construction Subcontractor shall furnish and install four prefabricated pre-engineered metal building, complete, as shown on the Drawings and as specified herein.

References

The following Codes and Standards, including others referenced therein, form a part of this Section to the extent specified herein:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC	Specification for Structural Steel for Buildings – Allowable Stress Design (ASD)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI	Specification for the Design of Cold-Formed Steel Structural Members

ASTM INTERNATIONAL (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A570	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A572	Standard Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel
ASTM A607	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled, and Cold-Rolled
ASTM F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 Structural Welding Code – Steel

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

Recommended Design Practices Manual, for applicable loads and load combinations

Metal Building Systems Manual, for collateral loads

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

UBC, Uniform Building Code

STEEL DOOR INSTITUTE (SDI)

SDI 100 Recommended Specifications for Standard Steel Doors and Frames

SDI 117 Manufacturing Tolerances Standard Steel Doors and Frames

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Manufacturer's Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.

Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed metal building system.

Painting System: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats. Provide minimum 20 color samples for Tank Farm Contractor to choose.

Drawings Stamped by Engineer Registered in the State of Washington and Prepared Specifically for this Project:

Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.

Calculations Stamped by Engineer Registered in the State of Washington: Complete structural stress and deflection analysis of structural components and connections; consider prying action of bolts should proposed design use bolted moment-resistant connections in main frames. Provide anchor bolt calculations and separately tabulate anchor bolt reaction for all case loads and load combinations.

Samples: Minimum 2-inch by 3-inch metal for components requiring color selection.

Submit documentation of construction quality control testing as specified herein.

Submittals–Approval Not Required

Information/Record (IR):

Statements of Qualification:

Documentation of past 5 years' experience record to include project name, location, type and date completed, building manufacturer and owner's contact person.

Certification of approval by manufacturer.

Vendor Information (VI):

Manufacturer's written instructions for shipping, handling, storage, protection and erection or installation of building and components.

Manufacturer's certification or proof of current membership in Metal Building Manufacturer's Association (MBMA).

Manufacturer's Certificate of Proper Installation.

Operations and maintenance manual.

Qualifications

Provide prefabricated metal buildings as produced by a manufacturer who is regularly engaged in fabrication of pre-engineered metal structures of type and quality indicated. All components shall be provided from one manufacturer.

Warranties

Warranty shall begin at the time of Substantial Completion.

The roofing and siding shall be warranted for a minimum of 5 years against wind damage, leakage, paint fade, chipping, peeling, attachment and rusting. Warranty shall include labor and materials for replacement of defective panels. Warranty shall not be pro-rated over 5-year period.

Finish on metal roof and wall panels, flashing, and trim will not chalk, crack, check, blister, peel, flake, chip, or loose adhesion shall be warrantied for 5 years.

Part 2 – Products

Manufacturer

Dimensions of the 12-foot by 12-foot buildings are based on Panl-Line Building System as manufactured by Butler Manufacturing Co. Dimension and sizes of the 21-foot by 16-foot buildings are based on the Parkline Building Systems, Inc. (Type AL), and VP Buildings, Inc. If an "or equal" building manufacturer is submitted and approved by the Engineer, all dimensions and clearances shall be taken as minimums for evaluation of submittal. Construction Subcontractor shall be responsible for all adjustments required to plans as a consequence of changing building manufacturer. All shop drawings and special process procedures as welding, painting and structural bolting, shall be submitted for approval and shall be stamped by a registered professional engineer licensed to practice in the State of Washington.

Type: The metal building shall be a prefabricated, weather-tight, free-standing building having a structural steel frame. The 12-foot by 12-foot buildings shall be self-framing buildings incorporating diagonal bracing. The 21-foot by 16-foot buildings shall be rigid frame in all walls with no diagonal bracing in the wall. The roof slope and the eave height shall be at as specified on Construction Drawings.

Design Loads

The building shall be designed for the following applied loads in addition to dead load:

Roof Live Loads: Roof covering shall be designed for 20 psf uniformly distributed load.

Roof Snow Load: Ground snow load is 15 psf, C_e = 10, I = 0.8 designed per ASCE 7.

Wind Loads: The wind load on the structure shall be designed per ASCE 7 and DOE STD-1020-02 using a 3-second gust wind velocity of 85-mph wind speed. Design and calculate according to the ASCE 7 exposure Class "C" with an Importance Factor = 1.0.

Seismic Loads: Seismic loads shall be determined and applied in accordance with the UBC Zone 2B, Importance Factor = 1.0, Soil S_c. Out-of-plane system stability, nonstructural components, and equipment shall be evaluated using UBC 1632.

Collateral Loads: All additional dead loads, other than the weight of the metal building system, such as fire sprinklers, mechanical HVAC systems, electrical systems, and ceilings. Collateral loads shall be a minimum of 10 pounds per square foot as defined in the Metal Building Systems Manual published by the MBMA.

Maximum Deflection: Deflection shall be limited to L/240 for DL and DL+LL for all building components.

Combination of Loads: Combined loads shall be as prescribed in the UBC.

Building Code Requirement: Design building, roof system, roof overhang including support framing, roof and wall panels, and fasteners for horizontal and uplift wind loads and earthquake forces.

Materials

Hot-Rolled Structural Shapes: Conform to ASTM A36 or A529.

Tubing or Pipe: Conform to ASTM A500, Grade B; ASTM A501, or ASTM A53.

Members Fabricated from Plate or Bar Stock: 42,000 psi minimum yield strength; Conform to ASTM A529, A570, or A572.

Members Fabricated by Cold Forming: Conform to ASTM A607, Grade 50.

Galvanized Steel Sheet: Conform to ASTM A446 with G90 coating. "Class" to suit building manufacturer's standards.

Structural Framing Components

Rigid Frames:

Rigid frames shall be hot-rolled structural steel, factory welded, and shop painted. Furnish complete with attachment plates, bearing plates, and splice members. Factory drilled for bolted field assembly.

Length of span and spacing of frames shall be as shown on Drawings except slight roof slope variations are acceptable to meet manufacturer's standard.

Wind Bracing: No "x" type rod bracing shall be used in bays where bracing would cross windows or door openings, or where the interior of the exterior walls are to be finished. Use portal frames where bracing is required at window or door openings.

Secondary Framing: Purlins, eave girts, girts, flange and sag bracings shall be "Z" or "C" roll formed sections no pre-punched for fasteners, and shall be shop prime painted. Roof purlins shall be spaced a maximum of 5-foot 0-inch O.C. Base channel, sill angle, purlin spacers; minimum 14-gauge cold-formed steel; and shall be shop prime painted.

Anchor Bolts: The anchor bolts for the rigid frames shall be carbon steel and designed by the pre-engineered building manufacturer. Location and placement shall be coordinated with the foundation rebar shown on the Drawings. Any changes in rebar placement shall be brought to the attention of the Construction Subcontractor and engineering calculations shall be provided taking into account the changed rebar location.

Bolts: Bolts shall be ASTM A325 in quantities necessary for design loads and connection details. Provide zinc- or cadmium-plated units when in direct contact with panels. Direct tension indicators shall conform to ASTM F959.

Fabrication:

Shop fabricate to the indicated size and section, complete with base plates, bearing plates, and other plates as required for erection, welded in place, and with all required holes for anchoring or connections shop drilled or punched to template dimensions.

Shop connections shall be power riveted, bolted, or welded.

Field connections shall be bolted. Install high strength threaded fasteners in accordance with "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."

Weld Construction:

Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in connecting welding work. Welding shall not be performed at the project site.

Construction General Contractor shall provide Certified Weld Inspector (CWI) to perform visual examination of all off-site welds in accordance with AWS D1.1, Section 6. Document weld acceptance on Construction Subcontractor Weld History.

Shop Painting:

Surfaces to be primed shall be cleaned of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSCP-SP1 for solvent cleaning.

Prime structural steel primary and secondary framing members with manufacturer's standard rust-inhibitive primer having over 50 percent rust-inhibitive pigment, such as organic zinc. No lead or chromate will be allowed.

Prime galvanized members, after phosphoric acid pretreatment, with zinc dust-zinc oxide primer.

Roofing And Siding

General: Provide roofing and siding sheets formed to general profile or configuration as specified. Provide flashings, closers, fillers, ridge covers, and other sheet metal accessories, factory formed of same material and finish as roofing and siding. Factory-applied baked enamel, in color selected by the Engineer.

Roof Panels:

The Interlocking-Standing Seam Roof Covering shall carry an Underwriters' Laboratories, Inc., Uplift Classification of not less than Class 90 and shall consist of material not less than 24-gauge aluminized coated steel with Kynar finish on exterior face. The panels shall be installed with the ribs upstanding and parallel to the roof slope.

All longitudinal interlocking ribs as well as any transverse end laps shall be properly sealed, according to the manufacturer's instructions, with non-drying sealant.

The roof panels shall be secured to each structural support by a steel clip concealed between the adjacent male and female ribs and fastened under that panel's weather surface. Clip shall be long enough to allow Styrofoam thermal spacer on top of purlin.

Penetrations through the roof panel by fasteners shall be limited to only those required at the rake eaves, at end laps and at the ridge. All exposed fasteners shall be fitted with weather-seal washers of hydrocarbon-based elastomer (synthetic rubber) with a compatible metal backing.

Thermal (break) spacers shall be provided continuously at each structural support to minimize thermal conductivity. The thermal spacer shall be a continuous Styrofoam strip, 3 inches by 1 inch thick.

Wall Panels Exterior: The interlocking-ribbed wall covering shall consist of panels of not less than 24 U.S. gauge, fluoropolymer enamel finished, aluminized coated steel with male and female ribs. The wall panels shall be applied to the structural framing with the interlocking ribs toward the interior of the structure. The interlocking ribs shall be secured at the base, at each intermediate girt, and at the support at which it terminates, by means of concealed fasteners, thus eliminating any through-wall fastening. Trim finish to match wall panel.

All interior fasteners, i.e., screws, bolts and nuts, etc., shall be of carbon steel having a protective coating of either zinc or cadmium.

Interior Liner Panels: Interior wall liner panels shall be provided throughout the building on all perimeter walls. The panels shall be 24 gauge, white with concealed fasteners. All panel joints shall be provided with sealer along the edges of each panel. The liner panels shall function as a vapor barrier. Length of panels shall be full height with no horizontal joints. Finish shall be as described below.

Sealing Tape: Sealing tape shall be 100 percent solids, pressure sensitive grey polyisobutylene compound tape with release paper backing. Not less than 1/2 inch wide and 1/4 inch thick, nonsag, nontoxic, nonstaining and permanently elastic.

Joint Sealant: Joint sealant shall be one-part elastomeric; polyurethane, polysulfide, or silicon rubber as recommended by building manufacturer.

Ice Stops: Provide ice stops to prevent snow and ice damage to gutters. Ice stops shall be "ICEJAX" as manufactured by Snowjax Inc., Mechanicsburg, Pennsylvania, or approved equal. "ICEJAX" shall be adhered with Loctite "Depend", or approved equal, to metal roof panels.

Rain Gutter and Downspouts: The rain gutter shall be continuous along the eaves of the building. The gutter shall be a surface mounted type with downspout size and number as called for by the building manufacturer or as shown on the drawings. Gutter shall be minimum 5 x 5 inches in cross section. Gutter and downspouts shall be standard design as manufactured by Metal Building Manufacturer, or approved equal. Gutter shall be installed with 1/4 inch per 10-foot 0-inch slope to downspout. Factory finish to match wall panels.

Insulation And Vapor Retarder

As specified in Section 07210, BUILDING INSULATION.

Doors

Steel Doors: 1-3/4-inch doors, conforming to ANSI/SDI 100, with manufacturer's standard. Provide exterior doors with top and bottom edges finished flush. Provide doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on drawings and schedules.

Exterior Doors: Unless otherwise indicated, Grade III, extra heavy duty, Model 2 (seamless) design), minimum 16 gauge galvanized steel sheet faces.

Door Frames

Provide metal frames for doors and other openings according to ANSI/SDI 100 and of types and styles as shown on drawings and schedules. Conceal fastenings unless otherwise indicated. Frames shall be No. 14 USS gage or heavier cold-rolled steel sheet. Form exterior frames of hot dip galvanized steel. Fabricate frames with mitered and welded corners.

Available manufacturers of steel doors include the following:

AMWELD Building Products Div.
Ceco Corp.
Curries
Fenestra
Republic Builders Products Corp.
Steelcraft Mfg. Co.

Thermal-Rated (Insulating) Assemblies: At all exterior locations, provide doors, which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236 or ASTM C 976. Unless otherwise indicated, provide assemblies with maximum apparent U factor for thermal-rated assemblies is 0.24 Btu/hr (ft^2) degrees F.

Heating, Ventilating, And Air Conditioning System

As specified in Section 15500, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM.

Fixed Louvers

Material: Factory finish to match wall panels.

Free Airflow: Minimum 50 percent.

Weather Projection: Drainage-type louver.

Insect Screen: Manufacturer's standard 14-Ga to 18-Ga galvanized steel wire mesh screen.

Pipe Penetrations

For pipe penetrations through the roof use a "DEKTITE" pipe flashing unit as manufactured by ITW Buildex, or approved equal. Provide a stainless steel hose clamp for positive sealing of flashing to pipe.

Wall Penetrations

Provide opening as required by HVAC air conditioning manufacturer.

Electrical And Lighting

As specified in Section 16005, ELECTRICAL.

Part 3 – Execution

Erection

Framing: Erect structural framing true to line, level and plumb, rigid and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use a non-shrinking grout as specified in Section 03301, CONCRETE, to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.

Bracing:

- Install diagonal rod or angle bracing in roof as required.
- Diagonal/rod bracing shall not interfere with ceiling purlins.
- Install portal frame bracing in sidewalls as specified.

Framed Openings: Provide shapes of proper design and size to reinforce opening and to carry loads and vibrations imposed, including equipment furnished under mechanical or electrical work. Securely attach to building structural frame.

Roofing and Siding

General:

- Install panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finish from damage.
- Provide weather seal under ridge cap. Flash and seal roof panels at eave, swaged joints and rake with manufacturer's standard rubber, neoprene, or other closures to exclude weather.

Roof Sheets:

Provide sealant tape at lapped joints of ribbed or fluted roof sheets, and between roof sheeting and accessories.

Apply sealant tape continuous to clean, dry surface of weather side of fastenings on end laps and on sidelaps of corrugated or nesting type, ribbed or fluted panels and elsewhere to make weatherproof to driving rains.

Wall Sheets:

Apply elastomeric sealant continuous between metal base channel (sill angle) and concrete foundation and elsewhere as necessary for waterproofing. Handle and apply sealant and backup in accordance with sealant manufacturer's recommendations.

Align bottoms of wall panels. Fasten flashings, trim around openings, etc., with self-tapping screws.

Provide small quantities of paint material and touch-up coatings damaged during construction in accordance with the manufacturer's direction.

Sheet Metal Accessories: Install louvers and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weather tight mounting.

Interior Wall Liner Panels: Install all wall liner panels as shown on the Drawings.

Certification: The Construction Subcontractor shall submit a certified statement that all standing seam metal roofing, flashings, rain gutter and downspout, wall panels, structural framing, and anchor bolts have been installed in strict accordance with the manufacturer's printed instructions and this specification.

Door Installation: Fit hollow metal doors accurately in frames, within clearance specified in SDI-100.

Hardware Schedule

Group No. 2:

Butts: 1-1/2 pair McKinney T4A3386 4.5 x 4.5 x BHMA 630.

Lockset: 1 Best 84-7-C-15D-S3 x BHMA 626.

Closer: 1 LCN P4041 x BHMA 673.

Rain Drip: 1 Pemko 346C.

Kick Plate: 1 SST–10 inches high by 0.05 inch thick.

Weather-stripping: 1 set Pemko 319CN x S88 x BHMA 628.

Door Bottom: 1 Pemko 430CRL x BHMA 628.

Threshold: 1 Pemko 254X4AFG x BHMA 628.

Construction Quality Control

High Strength Bolted Connections: Construction General Contractor shall provide special inspections to verify field connections with high strength bolts are installed in accordance with plans and specifications and AISC requirements.

END OF SECTION 13122

SECTION 13205 – LINED BOLTED STEEL LIQUID STORAGE TANKS SCHED. B

Part 1 – General

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designations only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D103	Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D130	Flexible-Membrane-Lining and Floating-Cover Materials for Potable Water Storage

ASTM INTERNATIONAL (ASTM)

ASTM A446	Steel Sheet, Zinc-Coated by the Hot-Dip Process, Structural quality
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated by the Hot-Dip Process
ASTM D413	Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate
ASTM D751	Standard Test Method for Coated Fabrics

FEDERAL STANDARDS (FS)

FS 5100	Preservation and Packing of Hand Tools; Tools and Tool Accessories for Power-Driven Metal Woodworking Machinery

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

UBC	Uniform Building Code

Description

This Specification sets the minimum standards for design and construction of two lined, bolted liquid storage tanks. The tanks shall be constructed from corrugated galvanized steel panels bolted together such that no field welding or onsite coating is required. The system shall provide an interior geosynthetic fabric to protect the factory fabricated membrane liner. A tank primary and secondary liner system shall be utilized.

Qualifications

Tank Manufacturer: At least five tanks presently in service, of similar size and character required for this Project, and minimum of 5 years' satisfactory operation.

Tank Installer: Certified by tank manufacturer that installer is qualified to do the work.

Registered Professional Engineer: Licensed in the state of Project with training and expertise in tank system design and installation. Able to recognize signs of potential tank system failure during the intended operating life of the tank. Able to assess and interpret information on the waste to be stored in the tank and the waste compatibility with the materials used for the tank and piping system.

Installation Inspector: Knowledge of the physical sciences and the principals of engineering acquired by a professional education and related practical experience. Trained and experienced in the proper installation of tank systems or components. Certified by tank manufacturer that the inspector is qualified and experienced in type of Work to be performed.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Statements of Qualifications:

Tank manufacturer.

Tank installer.

Registered professional engineer.

Installation inspector.

Tank Secondary and Primary Liners ~~and Floating Cover~~:

Material Samples: Within 15 days from Notice to Proceed: Samples of the materials proposed for use. Submit fifty (50) sample coupons, each 8 inches by 10 inches in size, for use by the Engineer to conduct leachate compatibility testing.

Manufacturer's Data: Manufacturer's descriptive data, specifications sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Installation Plan: Submit an installation plan for the liners and cover describing the proposed methods for liner and cover deployment, panel layout, seaming, repair, and protection. The plan shall also include a quality control program for the Construction General Contractor's activities related to liner and cover materials installation.

Factory Fabrication Inspection Data (Source Quality Control): Submit documentation of factory inspection as specified herein.

Drawings:

Tank and Equipment: Detailed drawings for tanks, anchor bolts and anchor bolt chains, and equipment, such as wall construction, pipe connections, ~~floating~~ cover, ~~floating cover water removal system~~, secondary containment system, and stilling wells for installation of level controls shall be stamped by the Registered Professional Engineer. Level controls are provided by others (see Section 13401, PICS). Drawings shall include a complete list of equipment and materials, including manufacturer's descriptive and technical literature, and installation instructions.

Calculations: Stamped by the Registered Professional Engineer. Complete structural stress analysis of structural components and connections and anchorage system to the concrete ringwall. Include anchor bolt reaction for all load cases and load combinations.

Design Assessment Report:

A written report providing the results of the tank system design assessment prepared and certified by the Registered Professional Engineer attesting that the tanks furnished under this section of the Specifications has sufficient structural integrity and is acceptable for the storing and treating of dangerous waste.

The assessment report shall contain the following:

Site map of the facility showing the proposed location of the tank system within the overall facility.

A sketch of the tank system including connected piping and fittings. Individual tanks shall be clearly labeled.

Structural design standards and criteria used with reference to applicable industry standards and recommended practice codes. Include all calculations for tanks and anchoring. Tank shell shall be designed based on full tank. Design parameters used in calculations shall be clearly indicated and labeled on clarifying sketches. Seismic considerations that are appropriate to the seismic risk zone shall be accounted for in the calculations.

Assessment of the compatibility of the leachate to be stored in the tank with the tank system materials. Show that the characteristics of the leachate to be stored are compatible with the material properties of the tank system, including material properties of the interior lining. Include the results of the chemical compatibility testing provided by the Engineer in this assessment.

Description and assessment of the secondary containment system, results of primary liner and secondary liner leak detection surveys, and collection of releases into the secondary containment system; compatibility of the materials in the secondary containment system with the leachate to be stored in the tank; strength of secondary containment system to withstand stresses from static head during a release, climatic conditions, nearby vehicle traffic, and daily operations; description of the leak detection system that will detect the failure of the primary containment structure or the presence of any release of leachate or accumulated liquid in the secondary containment system within 24 hours; a description of the corrosion protection for the exterior surface of the tank.

Assessment of ancillary equipment as shown on the Drawings (piping, fittings, flanges, valves, and pumps) associated with the tank including support and protection against damage and excessive stress due to excessive settlement, vibration, expansion, or contraction. Verify that peak flows and internal stresses are within the design limits specified by the manufacturer of the ancillary equipment.

The recommended inspection schedule once the tank is placed in service based on the performance of similarly designed tank systems operating under similar conditions.

A statement by the Registered Professional Engineer certifying that the tank system has been adequately designed and that the tank system has sufficient structural strength to ensure that it will not collapse, rupture, or fail under the design conditions. The certification shall include the following statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I

am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

The Registered Professional Engineer's signature and stamp must be placed below the certification statement.

Submittals–Approval Not Required

Vendor Information (VI):

Installation: Tank Installation Instructions.

O&M Manual:

Tank Materials: Submit operating and maintenance instructions prior to completion of the Project. The manual shall include the manufacturer's cut sheets, parts lists, and a brief description of all equipment and their operating features. Maintenance instructions shall include all routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Information/Record (IR): Submit documentation of construction quality control as specified herein.

Installation Inspection Report: A written report prepared by the Installation Inspector or the Registered Professional Engineer documenting the results of the tank system installation inspection. The installation inspection report shall contain the following:

The as-built site plan showing the location of the installed tank system.

An as-built drawing of the installed tank system including connected piping. Individual tanks shall be clearly labeled with ID numbers.

Inspection notes, photographs, and any other material used to document inspection activities.

An assessment of the tank system for structural damage or inadequate construction/installation including weld breaks, punctures, damage to protective coatings, cracks, and corrosion, and documentation of any defects discovered in materials, equipment, or installation procedures and measurements taken to correct these defects.

Documentation of tightness testing results demonstrating the tank system is tight prior to placing it in service.

A statement certifying the proper installation of the tank system liner, signed by the liner installer's representative.

A signed and dated statement by the Installation Inspector or Registered Professional Engineer certifying the proper installation of the tank system. The certification shall include the following statement:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Leachate Compatibility Testing

The Engineer will conduct leachate compatibility testing on the tank liner and cover material samples submitted by the Construction General Contractor in accordance with EPA SW 846, Method 9090, or ASTM D5322 and D5747 procedures. At the completion of the testing, the Engineer will evaluate the testing data for conformance with the project requirements and approve or reject the material. The Engineer will provide the results of the evaluation and approval or rejection to the Construction General Contractor within 180 days after receipt of material samples. Construction General Contractor shall not order materials or proceed with fabrication until after receiving results and approval from the Engineer. Any product or material changes required as a result of inadequate leachate compatibility results will be addressed by Change Order, provided that the submitted material meets all other requirements of this section.

Delivery and Storage

All materials and equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity, and excessive temperature variation; and dirt, dust, or other contaminants. The tank components shall be shipped in crate(s) or pallet(s) designed to prevent physical damage to the tank coating, linings, and structural components.

Warranty

The tank shall have a 3-year warranty from the date of Substantial Completion covering workmanship, materials, all steel components, and the liners and ~~floating~~ cover system. The warranty shall provide for correction, or, at the option of the Tank Farm Contractor, removal and replacement of Work specified in this Specification section found defective during the period of the warranty.

The Construction General Contractor shall provide the manufacturer's written warranty for the liners and cover. The warranty shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the liner and cover manufacturer. The warranty shall guaranty the liner and cover material for the above-stated period against:

Manufacturing Defects

Deterioration due to ozone, ultraviolet, and other exposure to the elements, including the stored leachate.

Defects in material and factory seams.

Defects resulting from installation.

Part 2 – Products

Manufacturer

Dimensions are based on bolted steel tank as manufactured by Environetics, Inc. All dimensions and clearances shall be taken as minimum if an "or equal" tank manufacturer is submitted and approved by the Engineer. Construction General Contractor shall be responsible for all adjustments required to Drawings as a consequence of changing tank manufacturer.

Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site. The items specified under this section shall be furnished by constructors having experience and regular practice in the design, fabrication, and construction of steel tanks.

Tank Size Requirements

Number of Tanks Required: Two.

Required Diameter: 101.46 feet.

Required Height: 8.17 feet.

Cover Required: Yes.

Leachate Volume: 375,000 gallons.

Top Capacity Level (TCL): 6.20 feet above tank floor.

Design

Design shall be in accordance with the requirements of AWWA D103.

Design Loads:

Specific Gravity: The tank shall be designed for liquids with a specific gravity of 1.00.

Earthquake: The tank shall be designed for Seismic Zone 2B per UBC and AWWA D103, site amplification soil profile C, I=1.0. For seismic, use leachate top capacity level (TCL).

Wind Force: The tank shall be designed to the greater requirements of a 100-mph wind with pressure loads as calculated with AWWA D103 or an 85-mph with pressure loads determined using ASCE 7, 1998. Wind force calculations shall include wind analysis with an empty tank case as well as a full tank case.

Hydrostatic Pressure: Design tank for static pressure to top of tank shell height.

Leachate Characteristics for Leachate Compatibility Testing:

Based on previous testing, the synthetic leachate for leachate compatibility testing of the tank liner material will have the following characteristics:

Chemical Compound	Concentration (g/l)
$NaNO_3$	185.0
Na_2SO_4	11.86

NaF	1.46
Na_2CO_3	3.45
$NaHCO_3$	2.44
pH	9.2 ± 0.1, using NaOH or HNO_3 as required

Tank Components

The tank and liner system shall consist of the following components: Corrugated steel wall panels with anchor embedded in concrete ringwall, geotextile base and wall buffer, secondary containment liner, drainage net, primary liner and ~~floating~~ cover, pipe connections, tank ladder, and piping for level and leak detection measurement.

Corrugated Steel Wall Panels:

The tank walls shall be constructed from individual rings of corrugated, hot-dip galvanized steel, mill-rolled to finished diameter. Sheet materials shall be ASTM A446, Grade D; or equal. Sheet materials shall be mill galvanized to ASTM A525, Class G90 standards, or equal. Shell plate thickness shall be based on AWWA D103 structural requirements. Wall plate thickness shall be a minimum of 12 gauge. Provide wind stiffeners as required by design.

Sheet materials shall receive an electrostatically applied, thermally cured, polyester powder coat finish. The coating shall be applied in two coats with a minimum dry film thickness of 5.0 mils. The finished coating shall be white in color.

Anchor Bolts: Shall conform to the requirements of AWWA D103.

Bolted Joints: Structural bolts conform to the requirements of AWWA D103 and shall be zinc electroplated. Bolted joints shall utilize a minimum two vertical rows as required to withstand structural loads.

Geotextile Base and Wall Buffer: An 8-ounce geotextile polypropylene nonwoven needle-punched fabric shall be placed on the tank floor and wall as a buffer for the liner. The fabric shall be designed to protect the liner from irregular surfaces on the tank wall. The material properties shall conform with the following:

Fabric Property	Unit	Test Method	Value
Grab Tensile Strength	lb	ASTM D4632	203
Grab Elongation	%	ASTM D4632	50
Puncture Strength	lb	ASTM D4833	130
Mullen Burst	psi	ASTM D3786	400
Trapezoid Tear Strength	lb	ASTM D4533	80
Permittivity[a]	sec^{-1}	ASTM D4491	1.5
Water Flow Rate[a]	gpm/sq ft	ASTM D4491	110
AOS	sieve	ASTM D4751	100
UV Resistance	% strength @ 500 hrs	ASTM D4355	70

(a) Minimum average roll values (MARV) for these secondary physical properties shall not exceed specified values.

Tank Secondary and Primary Liners ~~and Floating Cover~~:

The liners ~~and floating cover~~ shall be fabricated from polyester reinforced polymeric alloy. Sheet materials shall have UV resistance and weathering qualities and conform to the following properties:

Physical Property	Physical Values	Test Method
Thickness	30.0 mils min.	ASTM D751
Weight	30.0 ± 2 oz/yd^2	ASTM D751
Tear Strength	35/35 lb_f min.	ASTM D4533, Trapezoid Tear
Breaking Yield Strength	550/550 lb_f min.	ASTM D751, Grab Tensile
Low Temperature	Pass @ -30ºF	ASTM D2136, 4 hr – 1/8" mandrel
Dimensional Stability	1.5% max.	ASTM D1204, 212ºF – 1 h reach direction
Adhesion - Heat Sealed	35 lb_f/2 in min.	ASTM D751, Dielectric Weld
Seam	Dead Load - Seam Shear 2 in seam, 4 hr,	ASTM D751
Strength	1 in strip 210 lb_f @ 70ºF 105 lb_f @ 160ºF	
Bursting Strength	650 lb_f min.	ASTM D751
Ball Tip	800 lb_f typical	
Hydrostatic Resistance	800 psi min.	ASTM D751 Method A
Blocking Resistance	# 2 Rating max.	ASTM D751 (180ºF/82ºC)
Adhesion - Ply	15 lb_f/in min.	ASTM D413
or Film Tearing		
Bond		
Bonded Seam Strength	550 lb_f min.	ASTM D751 as modified by
NSF 54		
Abrasion Resistance	2,000 cycles (min.)	ASTM D3389
before fabric exposure	(H-18 Wheel, 1,000 g load)	
50 mg/100 cycles max		
weight loss		
Weathering Resistance	8,000 hrs (min.) –	ASTM G23 (Carbon-Arc)

Physical Property	Physical Values	Test Method
No appreciable changes or stiffening or cracking of coating		
Water Absorption	0.025 kg/m2 max.	ASTM D471 Section 12, @ 70ºF/21ºC
	7 days, 0.14 kg/m2 max.	@ 212ºF/100ºC
Wicking Shelter-Rite® Procedure	1/8 in max.	
Puncture Resistance	250 lbf min.	ASTM D4833
Coefficient of Thermal	8 x 10^{-6} in/in/ºF max.	ASTM D696

EXPANSION/CONTRACTION

Secondary and Primary Tank Liners: Shall be fabricated in a controlled factory environment into complete liners or large prefabricated panels. Size shall be limited to 3,000 pounds for ease of installation.

Tank Liner Source Quality Control: The tank liner(s) and cover shall be fabricated from standard width sheeting into a full-size fitted liner by means of minimum 1-inch wide dielectric and 2-inch wide thermal welds. The liner(s) and cover shall be thoroughly inspected by the fabricator for flaws in materials or fabrication prior to shipment. Inspection shall be performed by 100 percent visual inspection and proprietary inflation-light test methods. Construction General Contractor shall provide documentation of factory inspections to the Construction Manager.

~~**Floating Cover:** The cover shall be designed to comply with applicable AWWA D103 design standards. The cover shall incorporate closed-cell polyethylene foam floatation elements in cover membrane pockets to provide the required buoyancy, drainage, and wind stability. The cover shall incorporate a center vent to evacuate air during fill cycle. The manufacturers shall provide a pump system with pump to remove excess surface water. Floating cover shall drain towards the perimeter of the tank where excess water may be collected and pumped out. Cover vent shall include a base plate to prevent tipping due to wind or snow load.~~

Drainage Net: The floor area of the tank shall be covered with fitted panels of high density polyethylene (HDPE) drainage net with a geotextile laminated to both sides of the drainage net to prevent clogging and to provide a cushion for the HDPE drainage net against the tank liners. The drainage net shall be installed between the primary and secondary liners to convey liquids between the liners to a leak detection sump. Properties for the drainage net and geotextile are as follows:

Physical Properties	Test Method	Physical Value
Combined:		
Transmissivity, m/sec	ASTM D4716	4×10^{-5}
Drainage Net Component:		
Transmissivity, m/sec	ASTM D4716	1×10^{-3}
Thickness, mill	ASTM D1777	200
Density g/cm^3	ASTM D105	0.94
Tensile Strength, lb/in	ASTM D5034/5035	45
Carbon Black Content, %	ASTM D1603	2.0
Geotextile Component:		8 oz/yd^2
Thickness, mill	ASTM D5199	90
Grab Tensile, lb	ASTM D4632	210
Puncture Strength, lb	ASTM D4833	135 ± 5 lbs
AOS, US Sieve	ASTM D4751	80
Flow Rate, gpm/ft	ASTM D4491	110 ± 10 gpm/ft
UV Resistance, % retained	ASTM D4355	70

Pipe Connections: Pipe fittings and connections shall be in accordance with manufacturer's requirements for double containment connections. Location of pipe connections shall be as shown on the Drawings.

~~**Tank Ladder:** Provide a hot-dipped galvanized steel ladder for access to the floating cover pump. The ladder shall be attached at the top of the tank wall and at its base to the concrete ringwall. The ladder shall be of sufficient height to allow viewing of the floating cover system and its pump. The ladder shall be located adjacent to the tank level element installation.~~

Tank Level and Leak Detection Measurement:

Provide as part of tank construction two 2-inch diameter (Schedule 80 PVC) internal (stilling wells) that extend the whole interior operating height of tank, for the purpose of facilitating the installation of a submersible pressure transmitter (in one pipe), and a multipoint level sensor (in the other pipe). Level measurement instrumentation provided under Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), and installed by Construction General Contractor under this section.

Construction General Contractor shall furnish and install all necessary equipment and personnel to properly support installation of measurement devices (i.e., PVC flanges, straps, and gaskets).

Foundation: Tank shell to bear on a Type 1 concrete ringwall per AWWA D103 as shown on the Drawings. A 1-1/2-inch minimum space between the tank bottom and the top of the ringwall shall be filled with a nonshrink grout as specified in Section 03301, CONCRETE. Cane fiber joint filler shall not be used. Ringwall design is shown on Drawings.

Part 3 – Execution

General

Tank construction shall be in accordance with AWWA D103.

Tank Installation

Field erection of lined bolted steel tanks, including, but not limited to, shell plates, pipe connections, awning, primary and secondary containment, and ~~floating~~ cover, shall be in strict accordance with the manufacturer's recommendations including their guidance on environmental factors that could affect the tank installation.

Construction Quality Control

The Construction General Contractor shall establish and maintain a quality control system to assure compliance with contract requirements and shall maintain records of its quality control for all operations including, but not limited to the following:

- Inspection of materials delivered to project site against approved material data.
- Storage and handling of materials.
- Finished appearance.
- Completion of required testing.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the Construction Manager within 24 hours following the inspection or test.

Tank System Installation Inspection:

The Construction General Contractor shall provide the services of an Installation Inspector or Registered Professional Engineer to provide full-time supervision of the installation of the storage tanks. No work shall be performed without the presence in the field of the Installation Inspector or Registered Professional Engineer. The Installation Inspector or Registered Professional Engineer shall observe and verify that correct materials and procedures are used for the following activities:

- Visual inspection and testing.
- Subgrade and foundation preparation.
- Placement and compaction of backfill.
- Placement of reinforcing steel and anchor bolts.
- Concrete placement.
- Placement of shop-fabricated tank parts.
- Erection of field-erected tank parts.
- Installation of tank liner systems. Tank liner inspection requirements are specified herein.
- Installation of piping, pumping, and other ancillary equipment.
- Tightness testing.

Tank Liner Inspection:

Visual Inspection: 100 percent visual inspection along all seams of the liners.

Air Jet Inspection: 100 percent air jet inspection of all seams.

Any required repairs shall be corrected in accordance with the manufacturer's recommendations. Results of all testing shall be provided to the Construction Manager.

Electronic Leak Location Survey: Prior to installing the floating cover, complete an electronic leak location survey of the secondary and primary liners.

~~**Floating Cover Drainage Test:** Add water on floating cover to test that water drains towards the perimeter. Manufacturer to revise ballast if water does not drain to allow removal of excess water. Demonstrate proper operation of floating cover pump system to remove excess water.~~

Tank Tightness Testing: Upon completion of tank installation, the tank shall be visually inspected for any signs of physical damage. Any questionable areas shall be repaired in accordance with the manufacturer's instructions. The tank shall be filled with water and let stand for a period of not less than 2 days. The Construction General Contractor shall maintain a level not less than 7.2 feet for the duration of 2 days. Following the 2 days, the Construction General Contractor shall cyclically change the tank water level at a constant rate from 0.5 foot to 7.2 feet for four cycles over the next 28 days. During the 30 days, there shall be no signs of leakage from a defect in the primary liner to the secondary containment system of the tank. Any leaks discovered by this test shall be corrected by the Construction General Contractor in accordance with the manufacturer's recommendations. The tank system shall be successfully tested before it is accepted. Results of all testing shall be provided to the Construction Manager.

END OF SECTION 13205

SECTION 13401 – PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) SCHED. B

Part 1 – General

UL And NRTL Compliance

Materials manufactured within the scope of UL or another nationally recognized testing laboratory (NRTL) shall conform to UL or NRTL standards and have an applied UL or NRTL listing mark. References to UL throughout this section imply conformity with UL or NRTL standards and guidelines.

PICS control panels shall be manufactured, assembled, tested, approved, and clearly labeled in accordance with UL 508A when required, prior to delivery to construction site.

Approval by Authority Having Jurisdiction (AHJ): As specified in Section 16005, ELECTRICAL.

Work Includes

Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Tank Farm Contractor training for a complete Process Instrumentation and Control System for plant.

Detailed Design: PICS as shown and specified includes functional and performance requirements and component specifications. Complete detailed PICS design.

Major Cell No. 1 and Cell No. 2 components and controls to integrate into PICS and to program include:

- Crest Pad Building Control Panel, PLC, and Operator Interface Assemblies.
- Crest Pad Building Sump, Combined Sump, Leachate Tank, and Leachate Transfer Building Transfer Pump Local Control Panel Assemblies.
- Leachate Collection and Removal, and Leak Detection System Pump Control.
- Leachate Collection and Removal, and Leak Detection System Pump Discharge Flow and Flow Totalization.
- Leachate Collection and Removal System Continuous Level Measurement.
- Leak Detection System Continuous Level Measurement.
- Leachate Storage Tank Continuous Level Measurement.
- Leachate Storage Tank, Crest Pad Building Sump, Carrier Pipe, and Combined Sump Leak Detection Chamber Discrete Level Measurement.
- Crest Pad Building Sump Discrete Level Measurement, and Pump Control.
- Combined Sump Discrete Level Measurement, and Pump Control.
- Interlock Control between Crest Pad Building Sump and Leachate Collection, and Removal and Leak Detection System Pump Controls.
- Crest Pad and Leachate Transfer Building Continuous Temperature Measurement.
- Leachate Transfer Pump Control and Flow Measurement, and Flow Totalization.
- Crest Pad Building Discrete Power Measurement.

Definitions

Abbreviations

CAT: Construction Acceptance Test.

CP: Control Panel.

FDT: Factory Demonstration Test.

LCP: Local Control Panel.

MCC: Motor Control Center.

OIU: Operator Interface Unit.

PCT: PICS Continuity Test.

PFT: PICS Functionality Test.

PLC: Programmable Logic Controller.

SLC: Small Programmable Logic Controller.

Rising/Falling: Terms used to define actions of discrete devices about their set points.

Rising: Contacts change state when an increasing process variable rises through set point.

Falling: Contacts change state when a decreasing process variable falls through set point.

Signal Types:

Analog Signals, Current Type:

4 to 20 mA dc signals conforming to ISA S50.1.

Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:

Transmitter Type: Number 2, two-wire.

Transmitter Load Resistance Capacity:

Class L.
Fully isolated transmitters and receivers.

Analog Signals, Voltage Type:

1 to 5 volts dc within control panels only.
Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.

Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

Instrument Tag Numbers: In accordance with DOE-RL Standards.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

General:

Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.

Identify proposed items and options. Identify installed spares and other provisions for future work (e.g., reserved panel space; unused components, wiring, and terminals).

Bill of Materials: List of required equipment.

Group equipment items as follows:

I&C Components: By component identification code.

Other Equipment: By equipment type.

Data Included:

Equipment tag number.

Description.

Manufacturer, complete model number, and all options not defined by model number.

Quantity supplied.

Component identification code where applicable.

Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:

Catalog information, mark to identify proposed items and options.

Descriptive literature.

External power and signal connections.

Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

Component Data Sheets: Data sheets for I&C components.

Format and Level of Detail:

In accordance with ISA-S20.

Include component type identification code and tag number on data sheet.

Specific features and configuration data for each component:

Location or service.

Manufacturer and complete model number.

Size and scale range.

Set points.

Materials of construction.

Options included.

Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

Panel Construction Drawings:

Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.

Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.

Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.

Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.

Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.

Panel Control Diagrams: For discrete control and power circuits.

Diagram Type: Ladder diagrams. Include devices, related to discrete functions that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.

Item Identification: Identify each item with attributes listed.

Wires: Wire number and color. Cable number if part of multiconductor cable.

Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

Discrete Components:

Tag number, terminal numbers, and location (“FIELD”, enclosure number, or MCC number).

Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (e.g., Sump Level High).

Relay Coils:

Tag number and its function.

On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.

Relay Contacts:

Coil tag number, function, and coil location (ladder rung number and sheet number).

Show each circuit individually. No “typical” diagrams or “typical” wire lists will be permitted.

Ground wires, surge protectors, and connections.

Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.

Loop Diagrams:

Individual wiring diagram for each analog or pulse frequency loop.

Conform to the ISA S5.4 Standards.

Drawing Size:

Individual 11-inch by 17-inch sheet for each loop.

Divide each loop diagram into areas for panel face, back-of-panel, and field.

Show:

Terminal numbers, location of dc power supply, and location of common dropping resistors.

Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

Tabular summary on each diagram.

Transmitting Instruments: Output capability.

Receiving Instruments: Input impedance.

Loop Wiring Impedance:

Estimate based on wire sizes and lengths shown.

Total loop impedance.

Reserve output capacity.

Conduit and cable schedule names.

Interconnecting Wiring Diagrams:

Diagrams, device designations, and symbols in accordance with NEMA ICS 1.

Diagrams shall bear electrical Construction Subcontractor's signature attesting diagrams have been coordinated with Division 16, ELECTRICAL.

Show:

Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.

Component and panel terminal board identification numbers, and external wire and cable numbers.

Circuit names matching Conduit and Cable Schedule.

Intermediate terminations between field elements and panels for, e.g., to terminal junction boxes and pull boxes.

Pull boxes.

Factory Demonstration Test (FDT): Provide FDT documentation for control panels.

Installation Details:

Include modifications or further details required to adequately define installation of I&C components.

List of spares, expendables, test equipment and tools.

Submittals–Approval Not Required

Information/Record (IR): For PICS equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

Tank Farm Contractor Training Plan: In accordance with Article TRAINING.

Construction Quality Control Test Data: Provide documentation of PICS Continuity Test (PCT) and PICS Functionality Test (PFT).

Operation and Maintenance (O&M) Manuals:

Content and Format:

Complete sets O&M manuals, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.

Final versions of Legend and Abbreviation Lists.

Include:

Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PICS design.

Refer to paragraph Shop Drawings for the following items:

Bill of Materials.

Catalog Cuts.

Component Data Sheets.

Panel Control Diagrams.

Panel Wiring Diagrams, one reproducible copy.

Loop Diagrams, one reproducible copy.

Interconnecting Wiring Diagrams, one reproducible copy.

Device O&M manuals for components, electrical devices, and mechanical devices include:

Operations procedures.

Installation requirements and procedures.

Maintenance requirements and procedures including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Troubleshooting procedures.

Calibration procedures.

Internal schematic and wiring diagrams.

Component Calibration Sheets from field quality control calibrations.

List of spares, expendables, test equipment and tools provided.

List of additional spares, expendables, test equipment and tools recommended.

Factory Demonstration Test (FDT), PICS Continuity Test (PCT), and PICS Functionality Test (PFT) Submittals:

Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.

Final Test Procedures: Proposed test procedures, forms, and checklists.

Test Documentation: Copy of signed off test procedures when tests are completed.

Application Software Submittal and Design Workshops:

Location: There shall be a minimum of six (6) workshops held at the Tank Farm Contractor's facility (or by video and audio conferencing) during the course of the project.

Objective: To provide a vehicle by which the Tank Farm Contractor is able review and comment on PLC, OIU, communication hardware, standard software, and application software submittals and application software development.

Documentation: Application software supplier shall summarize resolutions reached in each workshop, including cost and schedule impacts and distribute copies to Tank Farm Contractor.

Order and minimum topics to be covered in each workshop:

Applications Software Design Workshop (kick off) that establishes project processes, including:

Workshop objectives.

Submittal process.

Review Work Sequence and schedule.

Loop Specifications, P&ID Review Workshop:

Application Software Supplier use P&IDs and Specifications to present how the proposed control system design and Applications Software will meet the functional requirements specified herein.

At the completion of workshop Applications Software Supplier modifies as necessary Loop Specifications.

Submit finalized Loop Specification along with an outline of any application software cost and schedule impacts.

PLC Software Standards Submittal Workshop: PLC Software Standards shall be developed in a Software Standards Workshop. Ladder diagram standards for commonly used functions, including the following:

Objective: To develop, implement, and review implementation of PLC Software Standards in ladder logic programming.

Ladder diagram standards for commonly used functions, including the following:

High and low process variable alarm checking.

Instrument failure alarm detection.

Equipment start/stop control.

Equipment failure detection.

Equipment run time.

Leak detection and equipment interlocks.

Signal filtering.

Flow totalization.

Alarm routines.

Interface with OIU.

Memory mapping, data transfer (read/write, remote set point adjustment, pump control and alarm management).

Submit for review ladder logic programming for each PLC including: descriptive ladder logic, cross references, memory map and point databases.

OIU Standard Workshop:

Objective: To develop, implement, and review implementation of OIU standards with Tank Farm Contractor.

Design Products and Topics to be Finalized:

OIU and PLC integration.

OIU tag naming conventions.

Process, set point, and runtime graphics.

Display paging and navigation.

Dynamic Objects:

Pumps, valves, gates, compressors, etc.

Equipment control through pop-up windows.

General data entry through the OIU.

Dynamic Objects:

Pumps, valves, gates, process indicators, indicators with alarms, data entry, controller face plate, and tanks.

Security.

Alarm Management.

Minimum OIU Design Products and Topics to be Finalized for Each OIU:

Eight (8) Process Graphics.

Eight (8) Pop-Up Equipment Operation Control Graphics.

One (1) Alarm Summary Process Control Graphic.

One (1) Alarm History Process Control Graphic.

One (1) Equipment Runtime Process Control Graphic.

One (1) Analog Process Summary Control Graphic.

Submit for review OIU programming and development for each OIU computer including: memory mapping, database structures, graphic displays, and alarms.

Delivery, Storage, and Handling

Provide site and warehouse storage facilities for PICS equipment.

Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

Cover panels and other elements that are exposed to dusty construction environments.

Electrical equipment (valves, instruments, sensors, enclosures) shall be wired complete and in accordance with the manufacturer's wiring diagrams and instructions.

Completed wiring diagrams shall be incorporated in the O&M submittal.

Environmental Requirements

Standard Environmental Requirements: Unless otherwise noted, provide equipment for continuous operation in these environments:

Freestanding Panel and Consoles:

Inside: NEMA 12.

Smaller Panels and Assemblies (that are not Freestanding):

Inside: NEMA 4X.

All Other Locations: NEMA 4X.

Field Elements: Outside.

Special Environmental Requirements:

Design panels for continuous operation in environments listed:

Building Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Transfer Pump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Leachate Transfer Buildings.

Leachate Storage Tank Local Control Panel to be installed outdoors adjacent to Cell No. 1 and Cell No. 2 Leachate Storage Tanks.

Combined Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Environmental Design Requirements: Environmental conditions are defined below:

Inside:

Temperature: 10 to 30 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous.

Outside:

Temperature: Minus 40 to 40 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous (except for interior of Combined Sump Assemblies).

Snow Accumulation: 5 inches.

Sequencing and Scheduling:

Activity Completion: The following is a list of key activities and their completion criteria:

Shop Drawings: Reviewed and approved.

Factory Demonstration Testing of Control Panels: Reviewed and accepted.

Hardware Delivery: Hardware delivered to site and inventoried by Tank Farm Contractor.

PCT: Completed and required test documentation accepted.

PFT: Completed and required test documentation accepted.

PICS Substantial Completion: When Construction Manager issues Certificate of Substantial Completion.

Prerequisites:

All PICS Submittals have been completed.
PICS has successfully completed FDT and PFT.
Tank Farm Contractor training plan is on schedule.
All spares, expendables, and test equipment have been delivered to Tank Farm Contractor.

PICS Acceptance: When Construction Manager issues a written notice of Final Payment and Acceptance.

Prerequisites:

Certificate of Substantial Completion issued for PICS.
Punch-list items completed.
Final revisions to O&M manuals accepted.
Maintenance service agreements for PICS accepted by which shall satisfy the following requirements:
Duration of 2 years unless negotiated with Tank Farm Contractor.

Start on date of PICS acceptance, as identified in Section 13401, PICS, Article SEQUENCING AND SCHEDULING, Paragraph PICS Acceptance.

Performed by factory trained service engineers with experience on PICS systems to be maintained.

All materials and labor for preventive maintenance and visit site bimonthly.

All materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Response Time: Service engineer shall be onsite within 24 hours of request by Tank Farm Contractor.

Spare Parts:

If not stocked onsite, delivered to Site within 24 hours from time of request.

Repair or replace all components or software found to be faulty.

Replace and restock within 1 month, onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.

Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each visit to site.

Telephone Support: Coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Software Subscription: 2-year support per Section 13401, PICS, Supplements.

Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer and Tank Farm Contractor	Tank Farm Contractor acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly.	Associated shop drawing Submittals completed
Shipment	Completion of PICS Shop Drawing and Quality Control Submittals, preliminary O&M manuals, and Factory Demonstration Testing.
PCT	PCT procedures completed; notice 3 weeks prior to start.
Tank Farm	Tank Farm Contractor training plan completed.
Contractor Training	
PFT	Startup, Tank Farm Contractor training, and PFT procedures completed; notice 4 weeks prior to start.

Part 2 – Products

General

The general functions of the PICS are as depicted on the Drawings. The PICS Contractor shall provide a full-featured system that is complete, calibrated, and fully operational.

Like Equipment Items: Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

Loop Specifications

Location: Article SUPPLEMENTS.

Organization: By unit process and loop number.

Functional Requirements for Control Loops: Shown on Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

Supplemented by Loop Specifications.

Subheadings for Each Loop:

Functions: Clarifies functional performance of loop, including abstract of interlocks.

Components: Lists major components for each loop. Information listed include: Tag numbers.

Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article SUPPLEMENTS.

Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, set points, and controller options.

I&C Components

Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article SUPPLEMENTS. Furnish all equipment that is necessary to achieve required loop performance.

Component Specifications: Generalized specifications for each type of component are located in Article SUPPLEMENTS.

Nameplates And Tags

Panel Nameplates: Enclosure identification located on the enclosure face.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 1/2-inch white on black background, unless otherwise noted.

Component Nameplates—Panel Face: Component identification located on panel face under or near component.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 3/16-inch white on black background, unless otherwise noted.

Component Nameplates—Back of Panel: Component identification located near component inside of enclosure.

Inscription: Component tag number.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:

Inscription: Refer to:

Table under paragraph Standard Pushbutton Colors and Inscriptions.

Table under paragraph Standard Light Colors and Inscriptions.

P&IDs in Drawings.

Materials: Engraved plastic, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.

Letters: Black on gray or white background.

Service Legends: Component identification nameplate located on face of component.

Inscription: As shown.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Nametags: Component identification for field devices.

Inscription: Component tag number.

Materials: 16-gauge, Type 304 stainless steel.

Letters: 3/16-inch imposed.

Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

Electrical Requirements

In accordance with Division 16, ELECTRICAL.

I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

Wires Within Enclosures:

ac Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current to be carried, but not less than No. 14 AWG.

Analog Signal Circuits:

Type: 600-volt stranded copper, twisted shielded pairs.

Size: No. 16 AWG, minimum.

Other dc Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current carried, but not less than No. 18 AWG.

Special Signal Circuits: Use manufacturer's standard cables.

Wire Identification: Numbered and tagged at each termination.

Wire Tags:

Snap-on or slip-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

Wires entering or leaving enclosures, terminate and identify as follows:

Analog and discrete signal, terminate at numbered terminal blocks.

Special signals, terminated using manufacturer's standard connectors.

Identify wiring in accordance with Division 16, ELECTRICAL.

Terminal Blocks for Enclosures:

Wire spare PLC I/O points to terminal blocks.

One wire per terminal for field wires entering enclosures.

Maximum of two wires per terminal for 18-WG wire for internal enclosure wiring.

Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.

General:

Connection Type: Screw compression clamp.

Compression Clamp:

Complies with DIN-VDE 0611.

Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.

Guides strands of wire into terminal.

Screws: Hardened steel, captive and self-locking.

Current Bar: Copper or treated brass.

Insulation:

Thermoplastic rated for minus 55 to plus 110 degree C.

Two funneled shaped inputs to facilitate wire entry.

Mounting:

Standard DIN rail.

Terminal block can be extracted from an assembly without displacing adjacent blocks.

End Stops: Minimum of one at each end of rail.

Wire Preparation: Stripping only permitted.

Jumpers: Allow jumper installation without loss of space on terminal or rail.

Marking System:

Terminal number shown on both sides of terminal block.

Allow use of preprinted and field marked tags.

Terminal strip numbers shown on end stops.

Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

Terminal Block, General-Purpose:

Rated Voltage: 600V ac.

Rated Current: 30 amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Spacing: 0.25 inch, maximum.

Test Sockets: One screw test socket 0.079-inch diameter.

Manufacturer and Product: Entrelec; Type M4/6.T.

Terminal Block, Ground:

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Green and yellow body.

Spacing: 0.25 inch, maximum.

Grounding: Ground terminal blocks electrically grounded to the mounting rail.

Manufacturer and Product: Entrelec; Type M4/6.P.

Terminal Block, Blade Disconnect Switch:

Rated Voltage: 600V ac.

Rated Current: 10-amp.

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Grey body, orange switch.

Spacing: 0.25 inch, maximum.

Manufacturer and Product: Entrelec; Type M4/6.SN.T.

Terminal Block, Fused, 24V dc:

Rated Voltage: 600V dc.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: LED diode 24V dc.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac:

Rated Voltage: 600V ac.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: Neon Lamp 110V ac.

Leakage Current: 1.8 mA, maximum.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac, High Current:

Rated Voltage: 600V ac.

Rated Current: 35 amps.

Wire Size: No. 18 to No. 8 AWG.

Rated Wire Size: No. 8 AWG.

Color: Grey.

Fuse: 13/32 inch by 1.5 inches.

Spacing: 0.95 inch, maximum.

Manufacturer and Product: Entrelec; Type MB10/24.SF.

Grounding of Enclosures: Furnish copper isolated ground bus. Take car to ensure that this bus is connected to the safety ground bus at only one point.

Single Point Ground for Each Analog Loop:

Group and connect shields in following locations:

Control Panel.

Ground terminal block rails to ground bus.

Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another and where required to provide proper function. Do not wire in series instruments on different panels, cabinets, or enclosures.

Power Distribution Within Panels:

Feeder Circuits:

One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.

Make provisions for feeder circuit conduit entry.

Furnish terminal blocks for termination of wires.

Power Panel:

Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.

Locate to provide clear view of and access to breakers when door is open.

Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.

Branch Circuit Breaker: Select size of circuit breaker to suit load at 250V ac.

Breaker Manufacturers and Products: Allen-Bradley 1492-GH.

Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:

Devices on Single Circuit: 20, maximum.

Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.

Branch Circuit Loading: 12 amperes continuous, maximum.

Panel Lighting and Service Outlets:

Put on separate 15-amp, 120V ac branch circuit.

Provide 120-volt ac plugmold for panel components with line cords.

Signal Distribution:

Within Panels: 4 to 20 mA dc signals may be distributed as 1 to 5V dc.

Outside Panels:

Isolated 4 to 20 mA dc only.

All signal wiring in twisted shielded pairs.

Between Panels: 4 to 20 mA dc signals isolated by current signal isolators.

Signal Switching:

Use dry circuit type relays or switches.

No interruption of 4 to 20 mA loops during switching.

Switching Transients in Associated Signal Circuit:

4 to 20 mA dc Signals: 0.2 mA, maximum.

1 to 5V dc Signals: 0.05V, maximum.

Current Signal Isolators: Solid state three- and four-way isolation of the input signal, two output signals, and external power supply.

Features:

Zero and span trim adjustments using 15-turn potentiometers.

Calibration independent of load.

Signal Interface:

Input: 4 to 20 mA dc maximum impedance: 75 ohms.

Output: Two 4 to 20 mA dc. Capable of drives output load impedance up to 1,050 ohms independent of supply voltage to isolator.

Enclosure: NEMA 1, unless otherwise noted.

Mounting: DIN rail, unless otherwise noted.

Power: 115V ac, unless otherwise noted.

Manufacturer: Moore ECT Isolators; or approved equal.

Intrinsic Safety: Programmable three-channel switching amplifier with intrinsically safe input circuits, used to isolate and transfer discrete signals from Class I, Class II, or Class III hazardous location to a nonhazardous location.

Inputs: Three-channel dry contact inputs to switching amplifier.

Outputs: Three-channel SPDT dry relay contact outputs, each selectable to be (N.O.) or (N.C.) Output function dependent upon input condition.

Indications: Two-color switching status LED for each channel. “Yellow” LED when output relay is energized. “Green” LED with power ON status, “Red” LED for Fault Condition.

Supply Voltage: 10-30 VDC.

Power Consumption: >2 watts.

Output contact Ratings: 500 VA/60W.

Approvals and Certifications: FM approved, and CSA Certified.

Manufacturer and Product: TURK MD13-231Ex0-R/24VDC or equal.

Relays:

General:

Relay Mounting: Plug-in type socket.

Relay Enclosure: Furnish dust cover.

Socket Type: Screw terminal interface with wiring.

Socket Mounting:

Rail.
Provide hold-down clips.

Control Circuit Switching Relay, Nonlatching:

Type: Compact general-purpose plug-in.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 28V dc or 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 1.2 watts (dc), 1.75VA (ac).

Expected Mechanical Life: 10,000,000 operations.

Expected Electrical Life at Rated Load: 100,000 operations.

Indication Type: Neon or LED indicator lamp.

Push to test button.

Manufacturer and Product: Allen-Bradley; 700-HA Series.

For all 11-pin relays use Allen-Bradley 700-HN203. For 8-pin relays, use Allen-Bradley 700-HN203.

Control Circuit Switching Relay, Latching:

Type: Dual coil mechanical latching relay.

Contact Arrangement: 2 Form C contacts.

Contact Rating: 10A at 28V dc or 120V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 2.7 watts (dc), 5.3VA (ac).

Expected Mechanical Life: 500,000 operations.

Expected Electrical Life at Rated Load: 50,000 operations.

Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

Control Circuit Switching Relay, Time Delay:

Type: Adjustable time delay relay.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Operating Temperature: Minus 10 to 55 degrees C.

Repeatability: Plus or minus 0.5 percent.

Timing Module: Solid state multifunction plug-in module. Plugs into socket to add timing feature to general purpose relay.

Manufacturer and Products: Allen-Bradley 700-HT1 for ac, 700-HT2 for dc.

Power Supplies:

Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.

Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with plus or minus 0.05 percent voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

Provide output over voltage and over current protective devices to:

Protect instruments from damage due to power supply failure.

Protect power supply from damage due to external failure.

Enclosures:

NEMA 1 in accordance with NEMA 250.

Mount such that dissipated heat does not adversely affect other components.

Fuses: For each dc supply line to each individual two-wire transmitter.

Type: Indicating.

Mount so fuses can be easily seen and replaced.

Resistors: All resistors used to derive a 1-5V dc signal from a 4-20 mA dc signal shall be 250 ohm, ±1 percent, 3 watts, axial lead, non-inductive wire wound, welded construction, silicone coated, 1,000V ac dielectric. Vishay-Dale RS-2B-NS or equal. 250 ohms is a standard value in this line, and use of a resistance other that 250 ohms is not acceptable.

Internal Panel Lights for Freestanding Panels:

Type: Switched 100-watt fluorescent back-of-panel lights.

Quantity: One light for every 4 feet of panel width.

Mounting:

Inside and in the top of back-of-panel area.
Protective metal shield for lights.

Service Outlets for Freestanding Panels:

Type: Three-wire, 120-volt, 15-ampere, GFI duplex receptacles.

Quantity:

For Panels 4 Feet Wide and Smaller: One.

For Panels Wider Than 4 Feet: One for every 4 feet of panel width, two minimum per panel.

Mounting: Evenly spaced along back-of-panel area.

Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted in Instrument List, Article SUPPLEMENTS.

Tag Function	Inscription(s)	Color
OO	ON	Red
	OFF	Green
OC	OPEN	Red
	CLOSE	Green
OCA	OPEN	Red
	CLOSE	Green
	AUTO	White
OOA	ON	Red
	OFF	Green
	AUTO	White
MA	MANUAL	Yellow
	AUTO	White
SS	START	Red
	STOP	Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red
Unused or Noninscribed Buttons		Black.

Standard Light Colors and Inscriptions: The following table gives the inscriptions for service legends, and the lens colors for indicating lights.

Tag Function	Inscription	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

Lettering Color:

Black on white and amber lenses.

White on red and green lenses.

Fabrication

General: Panels with external dimensions and instruments arrangement as shown on Drawings.

Panel Construction and Interior Wiring:

In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.

Fabricate panels, install instruments, wire, and plumb, at the PICS factory.

Electrical Work: In accordance with Division 16, ELECTRICAL.

Shop Assembly: No panel assembly other than correction of minor defects or minor transit damage shall be done on panels at site.

UL Label for Enclosures: UL label stating “Listed Enclosed Industrial Control Panel.”

Wiring Within PICS Panels:

Routed through slotted PVC wiring duct with mating cover.

Hinge Wiring:

Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

Arrange wiring neatly, cut to proper length, and remove surplus wire.

Abrasion protection for wire bundles, which pass through holes or across edges of sheet metal.

Connections to Screw Type Terminals:

Locking-fork-tongue or ring-tongue lugs.

Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations and to avoid crossovers at a 90 degree angle.

Wires terminated in a crimp lug, maximum of one.

Lugs installed on a screw terminal, maximum of two.

Connections to Compression Clamp Type Terminals:

Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.

Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two, or quantity as approved by manufacturer.

Splicing and tapping of wires, allowed only at device terminals or terminal blocks.

Terminate 24V dc and analog terminal blocks separate from 120V ac circuit terminal blocks.

Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.

Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

Temperature Control:

Freestanding Panels:

Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.

Ventilated Panels:

Provide all ventilated panels with louvers and fans with filters or other cooling means as required to maintain internal temperature between 40 degrees F to 90 degrees F.

For panels with backs against wall, furnish louvers on top and bottom of panel sides.

For panels without backs against wall, furnish louvers on top and bottom of panel back.

Louver Construction: Stamped sheet metal.

Ventilation Fans:

Furnish where required to provide adequate cooling.

Create positive internal pressure within panel.

Fan Motor Power: 120 volts, 60-Hz ac, thermostatically controlled.

Air Filters: Washable aluminum, Hoffman Series A-FLT.

Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.

Freestanding Panel Construction:

Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 12-gauge, unless otherwise noted.

Panel Fronts:

Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.

No seams or bolt heads visible when viewed from front.

Panel Cutouts: Smoothly finished with rounded edges.

Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

Internal Framework:

Structural steel for instrument support and panel bracing.

Permit panel lifting without racking or distortion.

Lifting rings to allow simple, safe rigging and lifting of panel during installation.

Adjacent Panels: Securely bolted together so front faces are parallel.

Doors: Full height, fully gasketed access doors where shown on Drawings.

Latches: Three-point, Southco Type 44.

Handles: "D" ring, foldable type.

Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.

Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.

Front and Side Access Doors: As shown on Drawings.

Nonfreestanding Panel Construction:

Based on environmental design requirements required and referenced in Article ENVIRONMENTAL REQUIREMENTS, provide the following:

For panels listed as inside:

Enclosure Type: NEMA 12 in accordance with NEMA 250.

Materials: Steel.

For all other panels:

Enclosure Type: NEMA 4X in accordance with NEMA 250.

Materials: Type 316 stainless steel.

Metal Thickness: 14-gauge, minimum.

Doors:

Rubber-gasketed with continuous hinge.
Stainless steel lockable quick-release clamps.

Manufacturers:

Hoffman Engineering Co.
H. F. Cox.

Factory Finishing:

Enclosures:

Stainless Steel and Aluminum: Not painted.

Nonmetallic Panels: Not painted.

Steel Panels:

Sand panel and remove mill scale, rust, grease, and oil.

Fill imperfections and sand smooth.

Prepare metal and paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.

Sand surfaces lightly between coats.

Dry Film Thickness: 3 mils, minimum.

Color: Light gray.

Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

Corrosion Protection

Corrosion-Inhibiting Vapor Capsule Manufacturers:

Northern Instruments; Model Zerust VC.

Hoffmann Engineering Co; Model A-HCI.

Source Quality Control

Factory Demonstration Testing (FDT):

Scope: Test PICS control panels to demonstrate panel assemblies are operational, prior to shipment:

Location: PICS factory.

Loop-Specific Functions: Demonstrate proper functions for each control loop, as shown on P&IDs and as required.

Make following documentation available to Construction Manager both before and after FDT:

Master copy of FDT procedures.

List of equipment to be tested including make, model, and serial number.

Equipment and loop verification sheets signed by PICS Construction Subcontractor showing that each equipment and loop has been tested and has functioned properly.

Part 3 – Execution

Examination

For equipment not provided by PICS, but that directly interfaces with the PICS, verify the following conditions:

Proper installation.

Calibration and adjustment of positioners and I/P transducers.

Correct control action.

Switch settings and dead bands.

Opening and closing speeds and travel stops.

Input and output signals.

Report discrepancies to the Construction Manager.

Installation

Material and Equipment Installation: Retain a copy of manufacturers' instructions at site, available for review at all times.

Electrical Wiring: As specified in Division 16, ELECTRICAL

Removal or Relocation of Materials and Equipment:

Remove from site materials that were part of the existing facility but are no longer used, unless otherwise directed by Construction Subcontractor to deliver to Construction General Contractor.

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

Construction Quality Control

Testing:

Onsite testing shall be required for each major process instrumentation and control system in accordance with this section and submitted/accepted test procedures. Provide personnel and equipment in support of PICS Continuity (PCT) and PICS Functionality (PFT) testing.

Tests shall be performed to demonstrate that each function is implemented and operational. These tests are electrical component tests to be performed in advance of facility-wide construction acceptance testing (CAT). CAT shall be performed in accordance with Division 1 requirements. Copies of all tests shall be submitted as specified herein.

Startup and Testing Team:

Thoroughly inspect installation, termination, and adjustment for components and systems.

Complete onsite tests.

Complete onsite training.

Provide startup assistance.

PICS Continuity Test (PCT) Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PICS is ready for operation.

Loop/Component Inspections and Calibrations:

Check PICS for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.

Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).

Project name.

Loop number.

Component tag number.

Component code number.

Manufacturer for elements.

Model number/serial number.

Summary of functional requirements, for example:

Indicators and recorders, scale and chart ranges.

Transmitters/converters, input and output ranges.

Computing elements' function.

Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).

Calibrations, for example:

Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.

Discrete Devices:

Actual trip points and reset points.

Space for comments.

These inspections and calibrations will be witnessed by the Construction Manager or designated representative(s).

PICS Functionality Test (PFT):

General:

Test all PICS elements to demonstrate that PICS satisfies all requirements.

Test Format: Cause and effect.

Person conducting test initiates an input (cause).

Specific test requirement is satisfied if correct result (effect) occurs.

Procedures, Forms, and Checklists:

Conduct tests in accordance with, and documented on, Tank Farm Contractor accepted procedures, forms, and checklists.

Describe each test item to be performed.

Have space after each test item description for sign off by appropriate party after satisfactory completion.

Required Test Documentation: Test procedures, forms, and checklists. All signed by Construction Manager and Construction General Contractor.

Conducting Tests:

Provide special testing materials, equipment, and software.

Wherever possible, perform tests using actual process variables, equipment, and data.

If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.

Define simulation techniques in test procedures.

Coordinate PICS testing with Construction Manager and affected Construction Subcontractors.

Test Requirements:

Once facility has been started up and is operating, perform a witnessed PFT on complete PICS to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.

Perform local and manual tests for each loop before proceeding to remote and automatic modes.

Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

Make updated versions of documentation required for PFT available to Construction Manager at site, both before and during tests.

Make one copy of O&M manuals available to Construction Manager at the site both before and during testing.

Training

General:

Provide an integrated training program to meet specific needs of Tank Farm Contractor's personnel in accordance with submitted and accepted training plan.

Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

Provide instruction on two working shifts as needed to accommodate the Tank Farm Contractor's personnel schedule.

Tank Farm Contractor reserves the right to make and reuse video tapes of training sessions.

Provide reference handouts that cover the course content for all personnel attending any course or training session.

Operations and Maintenance Training:

Include a review of O&M manuals and survey of spares, expendables, and test equipment.

Use equipment similar to that provided or currently owned by Tank Farm Contractor.

Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

Operations Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: Two.

Location: Site.

Content: Conduct training on loop-by-loop basis.

Loop Functions: Understanding of loop functions, including interlocks for each loop.

Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.

Interfaces with other control systems.

Maintenance Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: One.

Location: Project site.

Content: Provide training for each type of component and function provided.

Loop Functions:

Understanding details of each loop and how they function.

Component calibration.

Adjustments:

For example, controller tuning constants, current switch trip points, and similar items.

Troubleshooting and diagnosis for components.

Replacing lamps, fuses.

Component removal and replacement.

Periodic maintenance.

Cleaning/Adjusting

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

Cleaning:

Prior to closing system using tubing, clear tubing of interior moisture and debris.

Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

Protection

Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

Supplements

Supplements listed below, following "END OF SECTION," are part of this Specification.

Supplement 1—Instrument Listing for Cell No. 1 and Cell No. 2.

Supplement 2—Component Specifications.

Supplement 3—PLC Input and Output List.

Supplement 4—Loop Specifications.

Supplement 5—PLC and OIU Application Software Setpoints for Cells No. 1 and No. 2.

END OF SECTION 13401

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
1	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 1	48"W x 20"D x 72"High NEMA 12
2	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Operator Interface Unit	H-2-830855	Y50	NA			Ethernet Communication
20	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Main and Sub Breakers	H-2-830855	Reference 13401 PICS	NA			
21	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	High Density Breakers	H-2-830855	Reference 13401 PICS	NA			
22	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Surge Protection	H-2-830855	Reference 13401 PICS	NA			
23	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	24 V dc Power Supplies	H-2-830855	Reference 13401 PICS	NA			Size power supplies for all control loops and various local control panel power
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC, I/O, Power Supply and Chassis	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC Programming and Communication Software	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Laptop	H-2-830855	Y50	NA			
25	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Ethernet Switch and Mounting Bracket	H-2-830855	Y50	NA			
26	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Duct	H-2-830855	Reference 13401 PICS	NA			
27	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Analog	H-2-830855	Reference 13401 PICS	NA			
28	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Interposing Relays	H-2-830855	Reference 13401 PICS	NA			
29	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Discrete and Power	H-2-830855	Reference 13401 PICS	NA			
3	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Locking Mechanism	H-2-830855	Reference 13401 PICS	NA			

Instrument Listing for Cell No. 1 & Cell No. 2 — Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Cooling Fan	H-2-830855	Reference 13401 PICS	NA			
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Temperature Thermostat	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	
31	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Receptacle	H-2-830855	Reference 13401 PICS	NA			
32	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Uninterruptible Power Supply	H-2-830855	Y40	NA		Reference Controls on Dwg. H-2-830857 sheet 2	1050 VA, 120V in - 120V out The UPS system has been disconnected and removed and may be reinstalled in the future.
33	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Incandescent Lighting	H-2-830855	Reference 13401 PICS	NA			
34	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Signal Isolators	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	
96	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Alarm Dialer	H-2-830855	Y51	NA	NA		
97	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Cellular Modem (CDMA)	H-2-830855	Y52	NA	NA		
40	1	219(Y)	LH	LCP	002	Crest Pad Building Sump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
41	1	219(Y)	LH	LCP	003	Combined Sump Instrinsic Safety Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
68	1	219(Y)201	LH	LCP	004	Leachate Storage Tank Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
42	1	219(Y)1	LH	LCP	005	Leachate Transfer Pump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals

Instrument Listing for Cell No. 1 & Cell No. 2														Instrument Listing Sorted by Equipment Number
Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
91	1	219(Y)	LH	LCP	208	Secondary Leachate Collection System Local Control Panel	Enclosure	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA	NA	H-2-830849 sheet 2 of 2	16" W x 18" H x 9" D NEMA 4X - fiberglass reinforced polyester, with Data logger, input/output channel, signal converter, communications, rechargeable battery, and charge controller
95	1	219(Y)	LH	LED	208	Secondary Leachate Collection System Local Control Panel	Loop Powered Process Indicator	H-2-830854 sheet 1 of 4		NA	NA	H-2-830849 sheet 2 of 2	Red Lion, Model CUB4LP
4	1	219(Y)	LH	LI	101	Leachate Collection and Removal System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		
43	1	219(Y)	LH	LT	101	Leachate Collection and Removal System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX)
5	1	219(Y)	LH	LI	104	Leak Detection System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		
44	1	219(Y)	LH	LT	104	Leak Detection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	-	Sensor supplied with termination enclosure (TBX) under this section and installed by pump vendor
45	1	219(Y)	LH	HS	105	Crest Pad Building Sump Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 1 of 4	M12	NA	On/ Off		Bypass Operation
46	1	219(Y)	LH	LDE	105	Crest Pad Building Sump	Leak Detection Sensor	H-2-830854 sheet 1 of 4	L109	Actuate elevation 720.5	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
47	1	219(Y)	LH	LSH	105	Crest Pad Building Sump High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 722.0	Feet	Detail No. 1 on Dwg. H-2-830854	
48	1	219(Y)	LH	LSHH	105	Crest Pad Building Sump High High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 723.0	Feet	Detail No. 1 on Dwg. H-2-830854	

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
49	1	219(Y)	LH	LSL	105	Crest Pad Building Sump Low	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 721.0	Feet	Detail No. 1 on Dwg. H-2-830854	
50	1	219(Y)	LH	HS	107	Combined Sump Instrinsic Safety Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Bypass Operation
51	1	219(Y)	LH	LDE	107	Combined Sump Pump	Leak Detection Sensor	H-2-830854 sheet 2 of 4	L109	Actuate elevation 714.2	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
52	1	219(Y)	LH	LSH	107	Combined Sump High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 718.0	Feet	Detail No. 1 on Dwg. H-2-830854	
53	1	219(Y)	LH	LSHH	107	Combined Sump High High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 719.0	Feet	Detail No. 1 on Dwg. H-2-830854	
54	1	219(Y)	LH	LSL	107	Combined Sump Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 717.0	Feet	Detail No. 1 on Dwg. H-2-830854	
55	1	219(Y)	LH	LSLL	107	Combined Sump Low Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 715.0	Feet	Detail No. 1 on Dwg. H-2-830854	
92	1	219(Y)	LH	LT	108	Secondary Leachate Collection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830856	Signal interface shall be 12V dc supply instead of 24V dc
94	1	219(Y)	LH	FE	208	Secondary Leachate Collection System	Flow Meter	H-2-830854 sheet 1 of 4		1 to 20	GPM		Battery powered flow meter (Omega FTB 790 Series or approved equal).
7	1	219(Y)	LH	FI	202	Leachate Collection and Removal System Low Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 25	GPM		0-30 PSI Range
56	1	219(Y)	LH	FIT	202	Leachate Collection and Removal System Low Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 25	GPM	Section A on Dwg. H-2-830847	0-30 PSI Range with integral transmitter

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
57	1	219(Y)	LH	HS	202	Leachate Collection and Removal System Low Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
84	1	219(Y)	LH	PI	202	Leachate Collection and Removal System Low Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 30	PSI		0-30 PSI Range with Diaphragm Seal
58	1	219(Y)	LH	YL	202	Leachate Collection and Removal System Low Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
8	1	219(Y)	LH	FI	203	Leachate Collection and Removal System High Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 250	GPM		0-60 PSI Range
59	1	219(Y)	LH	FIT	203	Leachate Collection and Removal System High Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 250	GPM	Section A on Dwg. H-2-830847	0-60 PSI Range with integral transmitter
60	1	219(Y)	LH	HS	203	Leachate Collection and Removal System High Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
85	1	219(Y)	LH	PI	203	Leachate Collection and Removal System High Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 60	PSI		0-60 PSI Range with Diaphragm Seal
61	1	219(Y)	LH	YL	203	Leachate Collection and Removal System High Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
9	1	219(Y)	LH	FI	204	Leak Detection System Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 15	GPM		0-15 PSI Range
62	1	219(Y)	LH	FIT	204	Leak Detection System Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 15	GPM	Section A on Dwg. H-2-830847	0-15 PSI Range with integral transmitter
63	1	219(Y)	LH	HS	204	Leak Detection System Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
86	1	219(Y)	LH	PI	204	Leak Detection System Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
64	1	219(Y)	LH	YL	204	Leak Detection System Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
65	1	219(Y)	LH	HS	205	Crest Pad Building Sump Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
89	1	219(Y)	LH	PI	205	Crest Pad Building Sump Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
66	1	219(Y)	LH	YL	205	Crest Pad Building Sump Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
93	1	219(Y)	LH	DPI	206	Crest Pad Building	Wall-Mounted Differential Pressure Indicator	H-2-830854 sheet 1 of 4	Reference 15100 (LEACHATE FILTERS)	0 TO 15	PSID		With re-settable drag pointer
67	1	219(Y)	LH	HS	207	Combined Sump Pump	Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
69	1	219(Y)	LH	YL	207	Combined Sump Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
12	1	219(Y)	LH	HS	219	Crest Pad Building	Control Panel Mount Switch	H-2-830854 sheet 1 of 4	M12	NA			Alarm Acknowledge Switch
70	1	219(Y)	LH	JSH	219	Crest Pad Building	Power Relay	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA			Power Relay mounted inside Control Panel
10	1	219(Y)	LH	TI	219	Crest Pad Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 104	˚F		
71	1	219(Y)	LH	TIT	219	Crest Pad Building	Temperature Transmitter	H-2-830854 sheet 1 of 4	T3	-40 to 104	˚F		With integral transmitter
72	1	219(Y)	LH	YAL	219	Crest Pad Building	Alarm Light	H-2-830854 sheet 1 of 4	M31	NA			
11	1	219(Y)1	LH	TI	220	Leachate Transfer Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 104	˚F		
73	1	219(Y)1	LH	TIT	220	Leachate Transfer Building	Temperature Transmitter	H-2-830854 sheet 2 of 4	T3	-40 to 104	˚F		With integral transmitter
74	1	219(Y)1	LH	YAL	220	Leachate Transfer Building	Alarm Light	H-2-830854 sheet 2 of 4	M31	NA			
88	1	219(Y)201	LH	HS	301	Leachate Storage Tank Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Bypass Operation

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Number

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
75	1	219(Y)201	LH	LSHH	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 728.33	Feet	Detail No. 2 on Dwg. H-2-830854	
76	1	219(Y)201	LH	LSLL	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 722.7	Feet	Detail No. 2 on Dwg. H-2-830854	
77	1	219(Y)201	LH	LT	301	Leachate Storage Tank	Submersible Pressure Transducer	H-2-830854 sheet 2 of 4	L42	0 to 108	Inches	Detail No. 3 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX) and Lightning Arrestor
78	1	219(Y)201	LH	LI	301-1	Leachate Storage Tank	Local Control Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator, and Lightning Arrestor
6	1	219(Y)201	LH	LI	301-2	Leachate Storage Tank	Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator
79	1	219(Y)1	LH	HS	302	Leachate Transfer Pump	Panel Mount Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Motor On/Off control switch
87	1	219(Y)1	LH	PI	302	Leachate Transfer Pump	Pressure Gauge (Load)	H-2-830854 sheet 2 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
90	1	219(Y)1	LH	PI	303	Leachate Transfer Pump	Pressure Gauge (Suction)	H-2-830854 sheet 2 of 4	P4/P6	0 to 100	Inches		0-100 Inches Range with Diaphragm Seal
80	1	219(Y)1	LH	FIT/FQI	302-1	Leachate Transfer Pump	In-Line Flow Magmeter	H-2-830854 sheet 2 of 4	F4	0 to 300	GPM	Section A on Dwg. H-2-830851	0-15 PSI Range. Flow and Total Integral with same indicator.
81	1	219(Y)1	LH	YL	302-1	Leachate Transfer Pump	Local Control Panel Mount Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			
82	1	219(Y)1	LH	FQI	302-2	Leachate Transfer Pump	Local Control Panel Mount Flow Totalizer Indicator	H-2-830854 sheet 2 of 4	S27	0 to 10,000	Gal		Flow and Total Integral to same meter. Provided Signal Isolator
83	1	219(Y)1	LH	YL	302-2	Leachate Transfer Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
(Y) = A for Cell No. 1						For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.							
(Y) = E for Cell No. 2						For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.							

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Component Specifications

F4 Flow Element and Transmitter, Electromagnetic:

General:

Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

Type:

- Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
- Full bore meter with magnetic field traversing entire flow-tube cross section.
- Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.

Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

Service:

Stream Fluid:

- As noted.
- Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.

Flow Stream Descriptions: If and as described below.

Operating Temperature:

Element:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Transmitter:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Storage: 15 to 120 degrees F, typical, unless otherwise noted.

Performance:

Flow Range: As noted.

Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 33 feet per second.

Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

Features:

- Zero stability feature to eliminate the need to stop flow to check zero alignment.

No obstructions to flow.
Very low pressure loss.
Measures bi-directional flow.

Process Connection:

Meter Size (diameter inches): As noted.

Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.

Flange Material: Carbon steel, unless otherwise noted.

Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

Element:

Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.

Liner Material:

Teflon, unless otherwise noted.
Low activated waste leachate solution.

Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.

Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.

Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.

Grounding Ring:

Required, unless otherwise noted.

Material: Type 316 stainless steel, unless otherwise noted.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Transmitter:

Mounting: Integral, unless otherwise noted.

Display:

Required, unless otherwise noted.
Digital LCD display, indicating flow rate and total.

Bi-directional Flow Display:

Required, unless otherwise noted.
Forward flow rate.
Forward, net totalization.

Parameter Adjustments: By keypad or non-intrusive means.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Empty Pipe Detection: Drives display and outputs to zero when empty pipe

Signal Interface (at Transmitter):

Analog Output:

Isolated 4 to 20 mA dc for load impedance from 0 to at least 500 ohms minimum for 24V dc supply.
Supports Superimposed Digital HART protocol.

Cables:

Types: As recommended by manufacturer.

Lengths: As required to accommodate device locations.

Built-in Diagnostic System:

Features:

Field programmable electronics.
Self-diagnostics with troubleshooting codes.
Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
Initial flow tube calibration and subsequent calibration checks.

Factory Calibration:

Calibrated in an ISO 9001 and NIST certified factory.
Factory flow calibration system must be certified by volume or weight certified calibration devices.
Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

Factory Ready for Future In situ Verifications: If noted.

Original meter parameter values available from vendor by request.

Accessories:

In situ Verification System: If noted.

Quantity:

One complete system provided for the project.
Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.
Physical access to the flow-tube not required.
Meet standards established by the National Testing Laboratory.
Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.

Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.

Windows-based software

Primary Simulation System: If noted.

Quantity:

One complete system provided for the project.

Verifies proper operation of the signal converter by simulating the flow meter's output signal.

Generates pulsed dc excitation signal with a reference voltage of 70 mV.

Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.

Switch selectable for forward, reverse and zero flow rate.

Verifies various input and output signals.

Manufacturers:

Krohne Electromagnetic Integral Systems: Aqua Flux Flowmeter (size: 3/8 to 120 inches).

Endress & Hauser, Inc. Flow Measuring System: Promag 50/53W (size: 1 to 78 inches).

Invensys Foxboro (includes IMT 25 Series Intelligent Magnetic Flow Transmitter): 9100A Series Flanged Body Flow Tubes (size: 1 to 78 inches).

L1A Multipoint Level Element and Switches, Admittance:

General:

Function: Operate switches at two separate, distinct, preset product levels in a vessel.

Type: Admittance using low power radio frequency circuit.

Parts: Element and electronics unit. For remote mount, interconnecting cable.

Service: Fluid as noted.

Performance:

Set Points: As noted.

Temperature:

Operating range minus 40 to 140 degrees F.

Unaffected by coating buildup on element.

Features:

Electronics Unit:

Filtering: Built-in RFI protection.

Fail-Safe Contacts: Field convertible switch action.

Enclosure Type: Explosion-proof and weatherproof (NEMA 4).

Electronics Mounting: Integrally with element, unless otherwise noted.

When remote, provide cable with length as required to accommodate device locations.

Response Time: 20 milli-seconds standard, or as noted.

Element:

Type: Probe rod.

Insertion Length: As required to achieve noted set points.

Material: 316 stainless steel, unless otherwise noted.

Rating: Element and cable intrinsically safe.

Grounding Element: Required for nonmetallic tank applications.

Process Connection: 3/4-inch NPT unless otherwise noted.

Signal Interface: Contacts, 3 DPDT rated 5A continuous at 120V ac, minimum.

Power: 120V ac 50/60-Hz, or as noted.

Manufacturers and Products:

Drexelbrook; Model 506-3100.
Princo.
Endress & Hauser, Inc.

L8 Level Switch, Float:

General:

Function: Actuate contact at preset liquid level.

Type: Direct-acting float with an enclosed mercury switch and integral cable.

Service: Liquid; low activated waste leachate solution, unless otherwise noted.

Performance:

Set Point: As noted.

Differential: 1-inch maximum.

Temperature: 0 to 180 degrees F.

Features:

Entire Assembly: Watertight and impact-resistant.

Float Material and Size: Polyethylene/foam filled; 4.5-inch diameter tear drop.

Cable:

Combination support and signal.
Length as noted or as necessary per mounting requirements.
Type SO nitrile PVC jacket, AWG No. 18/2 or No. 18/4.

Mounting:

Pipe:

Cable-to-pipe clamp, corrosion-proof cable for 1-inch pipe.
Pipe-to-wall bracket for 1-inch pipe.

Suspended Type: As noted.

Signal Interface:

Switch Type: Mercury tilt.

Switch Contacts:

Isolated, rated 4.5A continuous at 120V ac.
As required (for example 1NO, 1NO+1NC) to meet functional requirements, or as shown.

Manufacturers and Products:

Consolidated Electric Co.; Model LS.
Anchor Scientific; Roto-Float, Type P/Type S.

L42 Level Element/Transmitter, Submersible, Wastewater:

General:

Function: Measure and transmit a signal proportional to level.

Type: Totally submersible pressure sensor (loop powered).

Parts: Sensor, interconnecting cable, sensor termination enclosure.

Service:

Fluid: Wastewater, unless otherwise noted.

Performance:

Process Range:

As noted.
Provide fixed factory range such that noted process range is between 40 and 80 percent of fixed factory range.

Accuracy: 0.25 percent of full scale.

Temperature, Operating: Minus 4 to plus 140 degrees F.

Overpressure:

Range dependent.
4X for ranges of 5 psig and above (to a maximum of 2,000 psi).
Greater than 4X for ranges below 5 psig.

Long Term Stability: Plus or minus 0.1 percent full scale/year, typical.

Features:

Sensor:

Silicon sensing element.
Titanium body.

Diaphragm: Titanium isolation, unless otherwise noted.

Pressure Connection:

Depth cone with radial inlet holes.
NEMA 6 rating (submersible to 2,300 feet).

Temperature Compensation: Plus 30 to 80 degrees F.

Dimensions:

Not to exceed 8.5L by 1.1 diameter, inches, nominal.
Loop powered, 9-30V dc.
Open face with perforated Protective Plate: Not to exceed 1.35 diameter, inches.

Interconnecting Cable:

Length:

As required.
Polyurethane sheathed.
Kevlar strain relief cord.
Integral vent tube.

Sensor Termination Enclosure:

Enclosure:

NEMA 4X, PVC/polycarbonate.
Desiccant module.
Micro filter.

Wall and 2-Inch Pipe Mounting Kit: Required, unless otherwise noted.

Lightning Arrestor(s): Required, unless otherwise noted.

Signal Interface: 4 to 20 Ma dc output, for load impedance of 0 to 750 ohms, minimum for 24V dc supply without load adjustment.

Area Classification: Intrinsically safe; certified for use in Class 1, Division 1, Groups A, B, C, and D atmospheres.

Manufacturers:

Druck; Type PTX 1830 with STE110.

Pressure Systems, Inc. KPSI; Series 720 with Series 815 Aneroid Bellows and Series 840 Junction Box.

Or approved equivalent.

L109 Level Detection Switch, Rises on Stem:

General:

Function: Actuate contact at preset liquid level.

Type: Direct acting; rises on stem.

Service: Liquid, water, wastewater, unless otherwise noted.

Performance:

Set point as noted.

Switch Actuation Point: Approximately 3/4-inch distance from end of stem to weighted support collar.

Operating Temperature Range: Minus 40 to plus 110 degrees F.

Features:

Assembly Material: Brass stem, Buna N Float, and Type 316 stainless steel wetted parts.

Float Size: 2-inch diameter.

Mounting: Suspension cable with compact-sized float, slosh shield, and weighted collar suspended in standpipes or sumps for leak detection.

Signal Interface:

Switch Type: Magnetic reed switch.

Switch Contacts:

SPST Isolated, rated at 20 VA.

NC (by inverting float on unit stem).

Cable and Lead Wires: No. 22 AWG, 25 feet of length of PVC jacketed cable.

Manufacturer and Product: GEMS; Specialty Switches Liquid Level Switch, Model LS-750.

M12 Hand Switch and Light, Oiltight, Round:

General:

Function: Select, initiate, and display discrete control functions.

Type: Heavy-duty, oiltight, industrial.

General Features:

Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.

Legend Plate: Standard size square style aluminum field and black markings, unless otherwise noted. Markings as shown.

Configuration: Light, pushbutton, or switch as noted or shown.

Light Features:

Lights: 6V ac lamps and integral transformer for operation from 120V ac, unless otherwise noted.

Lens Color: Color as specified under PANEL, STANDARD LIGHT COLOR AND INSCRIPTIONS, or as noted.

Pushbutton and Switch Features:

Guard: Full guard with flush button, unless otherwise noted.

Operator: Black pushbutton, black non-illuminated knob on switch, unless otherwise noted.

Boot: None, unless otherwise noted.

Signal Interface:

Contact Block:

Type: Silver-coated butting, unless otherwise noted.

Rating: 10 amps continuous at 120V ac or as noted.

Sequence: Break-before-make, unless otherwise shown.

Arrangement: Normally open or normally closed as shown, or perform functions noted.

Terminals: Screw with strap clamp, unless otherwise noted.

NEMA Rating: NEMA 4, watertight and dusttight and NEMA 13, oiltight.

Manufacturers/Models:

Allen-Bradley; Bulletin 800T.
Eaton Corp.; Cutler-Hammer, Type 10250T.
Square D Co.; Class 9001, Type K.

M31 Warning Light, Indoor/Outdoor:

General:

Function: Visual alarm.

Type: Rotating reflector or flashing bulb.

Parts: Light and spare bulbs.

Performance:

Temperature, Operating: Minus 35 to 190 degrees F.

Flash Rate: Nominally 90 per minute.

Features:

Dome Color: Amber, unless otherwise noted.

Lamp Life: 200 hours.

Lamp: Incandescent/25 watts.

Enclosure:

Type: Water-resistant closed cell neoprene gasket.

Mounting: Wall bracket, unless otherwise noted.

UL Listing: Indoor/outdoor use.

Power: 120V ac, 50/60-Hz.

Spare Bulbs: Two for each light.

Manufacturers:

- Federal Signal; Model 225.
- Benjamin Electric Manufacturing; Series KL-4000.

P4 Pressure Gauge:

General:

Function: Pressure indication.

Type: Bourdon tube or bellows.

Performance:

Scale Range: As noted.

Accuracy: Plus or minus 0.50 percent of full scale for Bourdon tube. Plus or minus 2-1-2% of span (ASME B 40.1 Grade A).

Features:

Liquid Filled:

- Required unless otherwise noted.
- Glycerin fill, unless otherwise noted.

Dial: 4-1/2-inch diameter, unless otherwise noted.

Case Material: Black phenolic plastic, unless otherwise noted.

Element Material: Phosphor-bronze, unless otherwise noted.

Pointer: Micrometer-adjustable.

Movement: Stainless steel, Teflon coated bearings, rotary geared.

Window: Glass, unless otherwise noted.

Socket Materials:

Brass, unless otherwise noted.
Threaded reinforced polypropylene front ring for easy zero adjustment.

Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.

Process Connection:

Mounting: Lower stem, unless otherwise noted.

Size: 1/2 inch, unless otherwise noted.

Connection Type: Threaded (NPT).

Manufacturers and Products:

Ashcroft; Duragauge Model 1279/1379.
Ashcroft LP Bellows Gauge Model 1188.
Weksler; Royal Process Gauge Model AAXX.
Ametek U.S. Gauge; Solfrunt Model 19XX.

P6 Pressure Seal, Diaphragm:

General:

Function: Isolate sensing element from process fluid.

Type: Fluid filled, corrosion resistant.

Service:

Pressure: Same as associated sensor.

Temperature: As noted.

Features:

Material Lower Housing: Type 316 stainless steel, unless otherwise noted.

Diaphragm Material: Type 316 stainless steel, unless otherwise noted. Bleed screw in upper housing.

Fill Fluid: As noted. Factory filled and assembled when possible.

Process Connections:

Instrument: 1/2-inch female NPT, unless otherwise noted.

Process: 1/2-inch female NPT, unless otherwise noted.

Connection Material: Compatible with pressure indicator and process lines.

Manufacturers:

Ametek, Mansfield and Green Division; Type SG.
Ashcroft; Type 101.
Ashcroft; Type 741.

S27 Indicator, Digital Panel:

General:

Function: Display analog signal, or totalize analog signal, and display engineering units.

Type: 7-segment digital, horizontal edgewise.

Performance:

Range: As noted, engineering units as noted.

Accuracy:

Plus or minus 0.1 percent full scale.
Temperature, Operating: 32 to 120 degrees F.

Features:

Digits: 4-1/2; 0.56-inch high minimum; 7-segment LED, gas plasma, or vacuum fluorescent.

Decimal Point: Field selectable.

Input Impedance: 100 ohms maximum.

Service Legend: Permanent, display of engineering units.

Response Time: 1 second maximum to 0.1 percent accuracy.

Signal Interface: 4 to 20 mA dc.

Enclosure:

Type: NEMA 4X.

Mounting: Panel; approximately 2-inch high, 4-inch wide, 5-inch deep.

Power: 120V ac, 50/60-Hz unless otherwise noted.

Manufacturers:

Red Lum Controls.
Action Instruments.
Analogic.
Moore Industries.

T3 Temperature Element and Transmitter, Resistance:

General:

Function: Measure the temperature of ambient, and transmit analog signal proportional to temperature.

Type: RTD.

Parts: Element and transmitter.

Service:

Process: As noted.

Process Temperature Range: As noted.

Element:

Type:

Single-element, unless otherwise noted
Three-wire, RTD.
Platinum, 100 ohm nominal at 0 degrees C.

Performance:

Accuracy: Greater of plus or minus 4 degrees F or plus or minus 0.75 percent of reading.

Features:

Dimensions:

1/4-inch diameter.
Length to accommodate thermowell insertion and extension lengths.
Spring-loaded element when well is used.

Sheath: Type 316 Stainless Steel, unless otherwise noted.

Process Operating Temperature Range: Minus 320 to 900 degrees F, unless otherwise noted.

Terminal Connection Head: General purpose, NEMA 4 weatherproof, unless otherwise noted.

Maximum Temperature: 220 degrees F, unless otherwise noted.

Thermowell Connection: Union Coupler, unless otherwise noted.

Sensitive Length: 1.6 inch minimum, measured from closed end.

Transmitter:

Ambient Operation Conditions.

Temperature: minus 40 to 140 degrees F, with display.

Relative Humidity: 0 to 100 percent, noncondensing.

Type: Two-wire, powered by a remote power supply.

Performance:

Accuracy: Greater of plus or minus 0.7 degree F or plus or minus 0.06 percent of span.

Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.

Electrical Safety: Standard unless otherwise noted.

Features:

Indicator:

Three line LCD, unless otherwise noted.
Automatic reference junction compensation.

Failsafe Mode:

User configurable ON, unless otherwise noted.
Downscale, unless otherwise noted.

Electric Damping: 1.2 seconds.

Signal Interface: 4 to 20 mA dc

Power: 24V dc external power supply.

Digital Communication: HART.

One HART communicator to be supplied for all HART capable transmitters, if not already supplied under another Specification section.

Enclosure:

Materials: Epoxy coated, low-copper aluminum, unless otherwise noted.

Type: NEMA 4X.

Mounting:

Wall, as noted.
For wall, provide stainless steel mounting set, unless otherwise noted.

Manufacturers and Products:

Foxboro; RTT20 Series Transmitter with PR Series RTD and Thermowell.

Rosemount; 78 Series Platinum RTD and Model 644H Transmitter.

Y40 Uninterruptible Power Supply System:

General:

Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.

Major Parts: Inverter, a battery charger, sealed battery.

Performance:

Capacity: As noted.

Input Power: 120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

Output Power: 120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

On-line Efficiency: 85 percent minimum, unless otherwise noted.

Backup Runtime:

Full Load: 9 minutes minimum, unless otherwise noted.

Half Load:

24 minutes minimum, unless otherwise noted.

Continuous no-break power with no measurable transfer time.

Sine-Wave Output Power Regulation:

Plus or minus 5 percent or less total harmonic distortion.

Meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.

Voltage Regulation: Plus or minus 3 percent nominal.

Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).

Lightning and Surge Protection:

Pass lightning standard ANSI/IEEE C62.41 Categories A and B test.

2000 to 1 attenuation of input spike.

Isolation:

True separately derived power source as per NEC Article 250-5d with output neutral bonded to ground.

Complete from line.

Less than 2 pF effective input to output capacitance.

Features:

Enclosure:

Floor mounted cabinet, unless otherwise noted.

RS232 external interface with full-duplex output capable of:

Remote monitoring of meter functions and alarm conditions.

Remote diagnostic testing.

Remotely set point display and adjustment.

Manufacturers:

Best Power, FERRUPS Uninterruptible Power System.

Controlled Power.

American Power Conversion; Back-UPS Pro.

Y50 Programmable Logic Controller and Operator Interface Unit System:

General:

Function: Microprocessor based system configured, assembled, and programmed in order to implement the safe automatic control and measurement of process control equipment.

System incorporates programmable logic controllers, processors, power supplies, operator interface units, communication hardware, programming and development software, and cables, and programming laptop.

Programmable Logic Controller (PLC):

Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.

PLC Parts: Central processing unit (CPU), power supply, local input/output modules, local (chassis/rack) controllers, I/O terminals board and termination cable assemblies, and factory assembled programming laptop, ETHERNET and OIU communication interconnecting cables.

PLC Central Processing Unit (CPU) Specifications:

Type: Microprocessor, 16-bit minimum.

Memory: 32K words.

I/O Capacity: 4096 inputs, 4096 outputs.

Standard RAM with lithium battery for 2 years backup.

Scan Time: 0.9 ms/1K ladder logic.

Communications:

Two communication ports, RS-232/RS485 and 10BASE-T Ethernet channel.

10 Mbps communications – TCP/IP protocol.

RS-232 and DH-485 Communication protocols.

Instruction Set: Timers and Counters.

Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, exponent, and compare.

Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.

Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants.

Real Time Clock: Date and time set and compare.

Miscellaneous: Jump or skip to a label, one shot, quantity drums, pre-configured analog alarm functions, subroutines, quantity.

Environment:

Operating Temperature: 0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degree C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 15 Watts.

Agency Approvals and Standards:

UL listed.

CSA certified.

or another state approved agency.

Random Access Memory (RAM):

Type: CMOS type.

Word Size: 16 bits, minimum.

Battery Backup: 24 months, minimum.

Memory Size: Sufficient to implement all applications software plus 50 percent spare.

Read only memory (ROM) for controller's operating system and diagnostics.

Memory Protection: Keylock switch.

Manufacture and Product: Allen-Bradley 1747-L552.

PLC Power Supply: One unit for each input/output base assembly.

Voltage: 120/220 volts (user selectable), 60 Hz input; 24 VDC output.

Mounting: Integral with PLC chassis.

Manufacture and Product: Allen-Bradley 1747-P4.

PLC Input/Output: Complete input/output system specifications:

Discrete Input Modules:

Voltage: 24 VDC.

Operating Power: 2 watts.

Points per Module: 16 maximum.

LED status indicator for each point.

Isolation: Between input point and PLC, 1,500 volts rms.

Discrete Output Modules:

Voltage: 24VDC.

Operating Power: 2 watts.

Load Rating: 2 amps continuous.

Isolation: Between PLC and output point, 1,500 volts rms.

Points per Module: 16 maximum.

LED status indicator for each point.

Isolated Discrete Output Modules:

Type: Isolated Form C relay.

Voltage: 120 volts, 60-Hz.

Isolated Outputs per Module: 8 Maximum.

Load Rating: 2 amps continuous.

Operating Power: 2.5 watts.

LED status indicator and fuse for each point.

Analog Input and Output Modules:

Voltage: 24 volts dc.

Power: 3 watts.

Differential Analog Points Per Module: 8 maximum.

Isolated Analog Output Points Per Module: 8 maximum.

Isolation: Between PLC and I/O point and between I/O points, 1,500 volts rms.

Analog Input Resolution: 12 bits minimum.

Analog Output Resolution: 12 bits minimum.

Manufacturer and Series: Allen-Bradley 1746 Series.

Operator Interface Unit:

Function: Panel mounted terminal unit with color video display screen and keypad, which enable an operator to monitor and interface with the process control system programmable logic controller. OIU linked with PLC over ETHERNET network.

Type: Microprocessor based device and programmable using Microsoft Windows based development software. *(Note: PICS PLC and OIU design is based upon the Allen-Bradley SLC-5/05E programmable logic controller and the Allen-Bradley Panelview 600 operator interface unit).*

Parts: Central processing unit (CPU), power supply, video display touch screen, keypad, Ethernet and printer ports.

Specifications:

Electrical: DC Power Supply Limits: 85 to 264 VAC AC Power, Power Consumption 60 VA maximum.

Mechanical: Enclosure NEMA Type 12/13, 4X (Indoor use only), LED Indicators – “Green” COMM, “Red” FAULT.

Display: Active Matrix Thin Film resistor (TFT) with cold cathode fluorescent (CCF) backlight.

Size: 4.54 x 3.4 in.

Pixels: 320 x 234.

Touch Cells: 128 (16 columns x 8 rows).

Touch Cell Size: (20 x 29 pixels).

Terminal Memory: total application flash memory 240K bytes (application screens)

Environment:

Operating Temperature: -0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degrees C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 32 Watts.

Agency Approvals and Standards: UL, CSA certified, or another state approved agency.

Manufacturer and Model: Panelview600 or equal.

Software Packages:

PLC Programming: Microsoft Windows based RSLogix500 programming and communication software (RSLinx) with master disk, most recent revisions, and 2-year support.

OIU Programming: Microsoft Windows based Panelbuilder32 development software with master disk, most recent revisions, and 2-year support.

Ethernet Switch:

Function: Mixed Media 10/100 Base T 8 port modular fiber switch with 4 port fiber module and 4 port RJ45 dual speed module.

Specifications: Address Table 24K nodes with address aging.

Cooling Method: Internal 9-CFM fan.

Filtering and Forwarding Rate: 16-port aggregate, 2380K packets per second.

Latency, 100 Mbps: 5 µs + packet time; 10 Mbps: 15 µs + packet time, Packet Buffers 8 MB dynamic.

Processing Type: Store and forward with IEEE 802.3x full-duplex flow control

Standards: IEEE 802.3: 10BASE-T, 10BASE-FL; IEEE 802.3u: 100BASE-TX, 100BASE-FX.

Connectors:

LE1401A, (1) power.

LE1419C: (4) pairs of SC.

LE1425C: (4) RJ-45.

Indicators Chassis: Power; Per port: LK: ON when link is operational; Act: ON with port activity; FDX/HDX: ON for full-duplex mode, OFF for half-duplex mode; 100/10: ON for 100 Mbps, OFF for 10 Mbps

Power Input: 110–240 VAC, 47–63 Hz, internal, autosensing; 20 W.

Size: 1.75 inches high (1U) by 17 inches wide by 9 inches deep (4.4 x 43.2 x 22.9 cm); weight: 2.5 pounds (1.1 kg).

Agency Approvals and Standards: UL, CSA or another state approved agency.

Manufacturer and Product: Black Box LE1401A; or equal.

Programming Notebook (Laptop) Computer:

Function: Notebook computer used to implement, test, and store all PLC and OIU application software programming. Install and configure all PLC and OIU vendor software packages and licenses onto laptop. Complete and save application software to notebook computer and to backup R/W CD(s).

Specifications:

Processor 2650: Intel Pentium 4-M processor at 2.0 GHz, 512 KB cache.

Memory: 128 MB DDR SDRAM standard, upgradable to 512 MB maximum, SDRAM configurations include one of 128, 192, 256, 384 or 512 MB.

I/O Ports:

25-hole pin parallel connector.

15-pin monitor connector.

6-pin PS/2-style keyboard, mouse, and keypad.

2-USB (Universal Serial Bus) compliant 4-pin connectors.

RJ-11 connector for modem.

RJ-45 connector for connection to Ethernet multimedia switch.

Chassis:

14.1-inch XGA Display: Height: 36 mm (1.42-inch); width: 328 mm (12.9-inch); depth: 275 mm (10.8-inch); weight: 7.25 lbs. with CD, floppy and battery.

Display: Displays 15-inch SXGA+ TFT active-matrix display with 1400 x 1050 resolution; height: 38 mm (1.5-inch); width: 332 mm (13.1-inch); depth: 275 mm (10.8-inch).

Power: Lithium Ion battery, AC Adapter: Input voltage: 90 to 135 VAC and 164 to 264 VAC.

Slots: Connectors: (1) Type I or Type II card, 3.3 and 5 V cards supported, Warm-swap Capable.

Graphics: 16MB DDR 4X AGP NVIDIA® GeForce2TM.

Storage: 20 GB4 Ultra ATA hard drive.

Optical Devices:

Fixed Bay integrated in left side with CD-RW: 24x/10x/24x max.

Removable Media: Fixed Floppy drive standard.

Communication Devices: Network Interface Cards, Integrated 10/100 network interface card.

Modems: Standard: Internal 56K5 capable v.92 Fax modem.

Software & Accessories: Microsoft® Windows® 2000 or XP Professional Small Business most recent version. Insure compatibility between platform and vendor software packages prior to installation.

Utilities: Norton AntiVirusTM 2003, introductory version.

Manufacturer and Model: Dell Inspiron 2650 or equal.

Y51 AutoDialer:

General:

Function: The Auto-dialer shall be a solid state component capable of bidirectional communication with the PLC network via cellular phone.

Environmental:

Operating Temperature Range: Minus 6°C to 54°C.

Relative Humidity: 0 to 95%, noncondensing.

Case: Suitable for mounting inside panel enclosure.

Features:

System Security: Access protected by security codes.

Alarm Monitoring: Continuously monitors all IDF alarms.

Remote Data-Table Access: Monitor or alter any data table location on demand via front panel or telephone.

Protocol: Allen-Bradley DFl.

Latency:

01-10 seconds.
Rotary pulse or tone dialing, keyboard selectable.
Dial up to 16 different numbers, each up to 60 digits long.
FCC Registered Part 68, "Ringer Equivalence": 0.3A.
Alarm Acknowledgment shall be Touch-Tone key or by calling back.
Autodialer shall be compatible with most cellular telephone systems.
Provide Serial Cable for use with AB SLC.
Autocall Test.
Nonvolatile Program Memory Retention.
Local Data Logging.

Primary Power:

Voltage: 120 VAC, 50/60 Hz

Standby Supply Current: 300mA.

Operational Supply Current: 460mA.

Battery backup: The product is to contain its own gel cell rechargeable battery, which is automatically kept charged when AC power is present. The system shall operate on battery power for a minimum of 13 continuous hours in the event of AC power failure.

Surge protection: All power, phone line, dry contact, and analog signal inputs shall be protected at the circuit board to IEEE Standard 587, category B (6,000 volts open circuit/3,000 amps closed circuit).

Diagnostics:

The unit shall include user commands to execute diagnostics of the PLC network to determine the health of the network. The unit shall inform the user of the length of scan time for the set of all configured remote channels.

AC Power failure.

Remote (PLC) Channel Monitoring: failure of the active serial communications channels.

Input Monitoring: with configurable aux contacts.

Warranty: The autodialer shall be covered by not less than a two (2) year warranty covering parts and labor performed at the Factory.

Agency Approvals: FCC Part 68.

Manufacturer and Product: RACO Verbatim Gateway Alarm Dialer or equivalent.

Y52 Cellular Modem (CDMA):

General:

Function: The Fixed Wireless Terminal shall provide wireless connectivity for standard telephone equipment.

Environmental:

Operating temperature range: -10°C to +50°C.

Storage temperature range: -40°C to + 60°C.

Relative Humidity: 5% to 95%.

Case: Suitable for mounting inside panel enclosure.

Features:

Compatible with popular supplementary services including caller ID, call waiting, 3-way calling, and call forwarding.

Single jack or dual jack for voice and fax operation.

PSTN Emulation.

Support up to five phones (5 REN).

Emergency battery backup.

Automatic end-of-dialing (no SEND key).

LED Indicators: shall include power/battery status, signal status, message status, and ON/OFF hook status.

Primary Air Interface Standard:

TIA/EIA/IS-2000A.

Primary Transmit Power:

200 mW (23dBm).

Frequency Ranges: Transmit/Receive:

CDMA800 824-849 MHz 869-894 MHz.

PCS (CDMA) 1900 1850-1910 MHz 1930-1990 MHz.

Primary Power:

Voltage: 110 - 230 VAC, 50/60 Hz.

Battery backup: One (1) 6-volt, 4 AH lead acid rechargeable battery.

Connectors:

Two RJ-11 interface jacks for telephone, Group 3 analog fax, or analog data.
TNC antenna connector (50 ohms).

Antennae:

Gain: 8.0 dBi minimum

Frequency Bands: 824 - 1000 and 1700 - 2000 MHz.

VSWR: Transmit sub-bands < 1.5:1, Receive sub-bands < 2.0:1.

Front to Back Ratio: (F/B Ratio) > 16 dB (nom).

Feed power handling: 10 W.

Nominal input impedance: 50 Ohms.

Connector: TNC male on short coax (30 - 50 cm).

Polarization: Linear (vertical when clamped to vertical pole).

Mounting: Pole mount, maximum diameter: 50 mm (2”).

Model Number: HGD-0 “High Gain Log Periodic Dipole Array”.

Warranty: The Cellular modem shall be covered not less than a fifteen (15) month warranty covering parts and labor performed at the Factory.

Agency Approvals:

FCC Part 15/Part 22/Part 24 Class B Compliance.

Manufacturer and Product: Phonecell® SX4E CDMA or approved equivalent.

Y178A Programmable Data Logger, Integral Solar Powered:

General:

Function: Programmable data logger and system capable of interfacing with process measurements loop powered analog device(s) for the purpose of measuring, collecting, storing and serially transferring process level data with externally connected programming and storage device (i.e. laptop computer).

Type: Microprocessor based.

Parts: Data logger, input/output channel, signal converter, communications, rechargeable battery, solar panel, charge controller, enclosure, and programming and data retrieval software. Vendor shall provide complete system meeting the intent of these specifications and contract drawings.

Service: Interface with Level/Element Transmitter, Submersible, Wastewater (Reference Section 13401 PICS Component L42 for detail information, Druck PTX 1830 and STE110 Level Element/Transmitter Submersible 12 V dc compatible or equal).

Performance:

Environmental:

Operating Temperature: Minus 67 degrees F to plus 185 degrees F (minus 25 to plus 85 degrees C), with gel cell battery, minus 40 degrees F to plus 140 degrees F (minus 40 to plus 60 degrees C).

Relative Humidity: 5 to 95 percent, non-condensing.

Central Processing Unit (CPU):

Processor: Hitachi 6303.

Memory:

Table based memory structure 62,000 data points.
Real time clock.
Diagnostic LEDs.
12-bit A/D converter.
16kB active program.
128kB operating and flash final storage.

Comm Port: 9-pin D type connector for RS232 interface with PC; up to 9600 baud selectable baud rates.

Manufacturer and Model: Campbell Scientific; CR510 Series with extended temperature test.

Input/Output Channel:

Analog Inputs:

Two (2) differential or four (4) single ended configured.

Range: 0 to 2.5 V dc.

Accuracy: +/-0.25 percent.

Resolution: 0.33 uV.

Sample Rates: 2.72 ms adjustable.

Manufacturer and Model: Campbell Scientific; Model CR510.

Terminal Input Channel Converter:

Convert 4-20mA to datalogger input range of 0 to 2.5V dc.

Shunt Resistor: 100 ohms.

Tolerance: +/- 0.01 percent.

Power: 0.25 watt.

Manufacturer and Model: Campbell Scientific; Model CURS100.

DC Power Supply:

Solar Panel, Regulator and Mounts:

Solar panel converting sunlight to DC power.

Voltage Peak: 16.8 volts.

Current at Peak, amps: 1.19 amps.

Peak Power: 20 watts.

Manufacturer and Model: Campbell Scientific; Model MSX20R.

Rechargeable Power Supply with Batteries:

Rechargeable power supply capable of recharging batteries from solar power.
Sealed rechargeable batteries providing 7.0 AHRS nominal output at 68 degrees F (20 degrees C).
Float charged by solar panel.

Manufacturer and Model: Campbell Scientific; Model PS100.

Enclosure: NEMA 4X - fiberglass reinforced polyester (FRP) 16 inches wide by 18 inches high by 9 inches deep (minimum) sized to accommodate datalogger, input/output channels, DC power supply, and sensor terminations.

Enclosure Mounting: Wall or pipe mounting as required.

Power Requirements: 5.4V dc to 16V dc.

Software Language: Pakbus operating system, and Microsoft® Windows® 2000 or XP based Datalogger Support and editing software and licenses complete and latest versions.

Support: Two (2) eight-hour days in support of installation, startup, calibration, and testing of complete system.

Training: One (1) eight-hour day in support of Tank Farm Contractor training on operations, setup, data retrieval, and troubleshooting of complete system.

Warranty: Three (3) years complete system beginning after system installation is complete and tested.

Manufacturer: Campbell Scientific.

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
1	1	219(Y)	LH	FIT	203	Leachate Collection and Removal System High Flow Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/00	No. 1	
2	1	219(Y)	LH	FIT	202	Leachate Collection and Removal System Low Flow Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/01	No. 1	
3	1	219(Y)	LH	FIT	204	Leak Detection System Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/02	No. 1	
4	1	219(Y)	LH	LT	101	Leachate Collection and Removal System Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/03	No. 2	
5	1	219(Y)	LH	LT	104	Leak Detection System Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/04	No. 2	
6	1	219(Y)	LH	TIT	219	Crest Pad Building Temperature	H-2-830854 Sheet 1 of 4	Fahrenheit	4-20mA	I:01/05	No. 3	
7	1	219(Y)201	LH	LT	301	Leachate Storage Tank Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/06	No. 2/ No. 6	Add Signal Isolator
8	1	219(Y)1	LH	FIT	302	Leachate Transfer Pump Discharge Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/07	No. 1/ No. 6	Add Signal Isolator
9	1	219(Y)1	LH	TIT	220	Leachate Transfer Building Temperature	H-2-830854 Sheet 1 of 4	Fahrenheit	4-20mA	I:02/00	No. 3	
10	1	219(Y)	LH			Spare Input			4-20mA	I:02/01		Wire in spare inputs

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
11	1	219(Y)	LH			Spare Input			4-20mA	I:02/02		Wire in spare inputs
12	1	219(Y)	LH			Spare Input			4-20mA	I:02/03		Wire in spare inputs
13	1	219(Y)	LH			Spare Input			4-20mA	I:02/04		Wire in spare inputs
14	1	219(Y)	LH			Spare Input			4-20mA	I:02/05		Wire in spare inputs
15	1	219(Y)	LH			Spare Input			4-20mA	I:02/06		Wire in spare inputs
16	1	219(Y)	LH			Spare Input			4-20mA	I:02/07		Wire in spare inputs
17	1	219(Y)	LH	HS	203	Leachate Collection and Removal System High Flow Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/00	No. 4	
18	1	219(Y)	LH	YL	203	Leachate Collection and Removal System High Flow Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/01	No. 4	
19	1	219(Y)	LH	HS	202	Leachate Collection and Removal System	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/02	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
						Low Flow Pump Auto Status						
20	1	219(Y)	LH	YL	202	Leachate Collection and Removal System Low Flow Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/03	No. 4	
21	1	219(Y)	LH	HS	204	Leak Detection System Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/04	No. 4	
22	1	219(Y)	LH	YL	204	Leak Detection System Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/05	No. 4	
23	1	219(Y)	LH	LSH	105	Crest Pad Building Sump Level High	H-2-830854 Sheet 1 of 4	High/Normal	24V dc	I:03/06	No. 4	
24	1	219(Y)	LH	LSHH	105	Crest Pad Building Sump Level High High	H-2-830854 Sheet 1 of 4	High-High /Normal	24V dc	I:03/07	No. 4	
25	1	219(Y)	LH	LSL	105	Crest Pad Building Sump Level Low	H-2-830854 Sheet 1 of 4	Low/Normal	24V dc	I:03/08	No. 4	
26	1	219(Y)	LH	LDE	105	Crest Pad Building Sump Leak Detector	H-2-830854 Sheet 1 of 4	Leak/Normal	24V dc	I:03/09	No. 4	
27	1	219(Y)	LH	JSH	219	Crest Pad Building Power Status	H-2-830854 Sheet 1 of 4	Normal/Fail	24V dc	I:03/10	No. 4	
28	1	219(Y)	LH	HS	205	Crest Pad Building Sump Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/11	No. 4	
29	1	219(Y)	LH	YL	205	Crest Pad Building Sump Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/12	No. 4	
30	1	219(Y)	LH	HS	219	Crest Pad Building General Alarm Acknowledge Status	H-2-830854 Sheet 1 of 4	Acknowledge/ Off	24V dc	I:03/13	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
31	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:03/14	No. 4	Wire in spare inputs
32	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:03/15	No. 4	Wire in spare inputs
33	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:04/00	No. 4	Wire in spare inputs
34	1	219(Y)201	LH	LSHH	301	Leachate Storage Tank Level Switch	H-2-830854 Sheet 2 of 4	High High/Normal	24V dc	I:04/01	No. 4	
35	1	219(Y)201	LH	LSLL	301	Leachate Storage Tank Level Switch	H-2-830854 Sheet 2 of 4	Low Low /Normal	24V dc	I:04/02	No. 4	
36	1	219(Y)	LH			Spare			24V dc	I:04/12	No. 4	Wire in spare inputs
37	1	219(Y)1	LH	YL	302-2	Leachate Transfer Pump On Status	H-2-830854 Sheet 2 of 4	On/Off	24V dc	I:04/04	No. 4	
38	1	219(Y)	LH	LSHH	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	High High/Normal	24V dc	I:04/05	No. 4	
39	1	219(Y)	LH	LSH	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	High /Normal	24V dc	I:04/06	No. 4	
40	1	219(Y)	LH	LSL	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	Low/Normal	24V dc	I:04/07	No. 4	
41	1	219(Y)	LH	LSLL	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	Low Low/Normal	24V dc	I:04/08	No. 4	
42	1	219(Y)	LH	LDE	107	Combined Sump Leak Detector	H-2-830854 Sheet 2 of 4	Leak/Normal	24V dc	I:04/09	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
43	1	219(Y)	LH	HS	207	Combined Sump Pump Auto Status	H-2-830854 Sheet 2 of 4	On/Off/Auto	24V dc	I:04/10	No. 4	
44	1	219(Y)	LH	YL	207	Combined Sump Pump On Status	H-2-830854 Sheet 2 of 4	On/Off	24V dc	I:04/11	No. 4	
45	1	219(Y)	LH			Spare			24V dc	I:04/12	No. 4	Wire in spare inputs
46	1	219(Y)	LH			Spare			24V dc	I:04/13	No. 4	Wire in spare inputs
47	1	219(Y)	LH			Spare			24V dc	I:04/14	No. 4	Wire in spare inputs
48	1	219(Y)	LH			Spare			24V dc	I:04/15	No. 4	Wire in spare inputs
49	1	219(Y)	LH	YS	203	Leachate Collection and Removal System High Flow Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/00	No. 4	Note: Interlock Control
50	1	219(Y)	LH	YS	202	Leachate Collection and Removal System Low Flow Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/01	No. 4	Note: Interlock Control
51	1	219(Y)	LH	YS	204	Leak Detection System Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/02	No. 4	Note: Interlock Control

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
52	1	219(Y)	LH	YS	219	Crest Pad Building General Alarm	H-2-830854 Sheet 1 of 4	Normal/Fail	120 Vac	O:05/03	No. 5	
53	1	219(Y)	LH	YS	205	Crest Pad Building Sump Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/04	No. 4	Note: Interlock Control
54	1	219(Y)	LH	YS	207	Combined Sump Pump Start Command	H-2-830854 Sheet 2 of 4	Start/Stop	120 Vac	O:05/05	No. 4	Note: Interlock Control
55	1	219(Y)1	LH	YS	220	Leachate Transfer Building General Alarm	H-2-830854 Sheet 2 of 4	Normal/Fail	120 Vac	O:05/06	No. 4	Note: Interlock Control
56	1	219(Y)	LH			Spare Output			24V dc	O:05/07	No. 5	
57	1	219(Y)	LH			Spare Output			24V dc	O:06/00	No. 4	Wire in spare outputs
58	1	219(Y)	LH			Spare Output			24V dc	O:06/01	No. 4	Wire in spare outputs
59	1	219(Y)	LH			Spare Output			24V dc	O:06/02	No. 4	Wire in spare outputs
60	1	219(Y)	LH			Spare Output			24V dc	O:06/03	No. 4	Wire in spare outputs
61	1	219(Y)	LH			Spare Output			24V dc	O:06/04	No. 4	Wire in spare outputs

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
62	1	219(Y)	LH			Spare Output			24V dc	O:06/05	No. 4	Wire in spare outputs
63	1	219(Y)	LH			Spare Output			24V dc	O:06/06	No. 4	Wire in spare outputs
64	1	219(Y)	LH			Spare Output			24V dc	O:06/07	No. 4	Wire in spare outputs
65	1	219(Y)	LH	HS	001	Handswitch in Interlock Relay Cabinet						
66	1	219(Y)	LH	YL	001	Indicator Light in Interlock Relay Cabinet						

(Y) = A for Cell No. 1. For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.

(Y) = E for Cell No. 2. For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.

Loop Descriptions

Supplement 4 PLC and OIU Application Software

Document Objectives

This Supplement No. 4 to Specification Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) provides the basis for estimating the minimum level of effort required to implement PLC and OIU application software for Cell No. 1 and Cell No. 2 Integrated Disposal Facilities (IDF).

Unless otherwise directed by the Tank Farm Contractor during Application Software Submittal and Design Workshops, this document provides guidelines for the programming and testing of all PLC and OIU application software. *Note: Issues related to Application Software Submittal and Design Workshops are discussed in Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS).*

This Supplement No. 4 shall be used in conjunction with Contract Documents (drawings and specifications, and supplements) and relevant PICS supplier technical information and manuals while developing application software.

PICS Supplements shall be provided to Construction General Contractor in electronic format upon request.

Reference Management Directive TFC–MD–034, Rev. A, attached to this supplement for directives on HMI (OIU) configurations.

PLC And OIU Program Layout

1. Programmable Logic Controller (PLC) Application Software: Provide PLC application software as necessary for a fully functional and operable PLC system in accordance with the project design. PLC programming includes, but shall not be limited to the following:
   a. PLC application software development and installation
   b. PLC equipment configuration
   c. PLC interface with Operator Interface Unit (OIU)
   d. System testing
   e. PLC application software debugging and trouble-shooting
   f. System hardware and software documentation
   g. PLC system startup
   h. PLC system training.
2. ETHERNET Address: For more information on SLC500 Ethernet Addressing see Allen-Bradley Quick Start Ethernet SLC500 Processor > Publication 1747-10.4.
   a. Host Name: (To be assigned by Tank Farm Contractor)
   b. IP Address: (To be assigned by Tank Farm Contractor)
   c. Subnet Masking: 255.255.255.0
   d. Gateway address: None

3. PLC Memory Allocation: Provide PLC programming and documentation with logical, structured groupings of PLC memory registers. Allocate memory within each group to allow for 50 percent spare capacity. Examples of functional groupings shall be:

   a. Inputs > I:01/00
   b. Outputs > O:01/00
   c. Control Operation Bits > B3:0 through B3: 200
   d. Timers > T4:0 through T4:100
   e. Counter > C5:0 through C5:100
   f. Sequencers > R6:0 through R6:100
   g. Ethernet Diagnostic Files > N7:00 through N7:50
   h. Scaled Analog Inputs > F8:00 through F8:49
   i. Process Calculations, Runtime, and Flow Totalization > F8:50 through F8:100
   j. Process Set-points, Comparisons, and Scaling Ranges for Analog Inputs > F9:0 through F9:100
   k. Reserve for future SCADA Discrete Write Commands to Processor > N10:0 through N10:100
   l. Reserve for future SCADA Analog Write Commands from Processor > F11:0 through F11:100
   m. Reserve for future SCADA Discrete Read Status from Processor > N12:0 through N12:100
   n. Reserve for future SCADA Analog Read Status from Processor > F13:0 through F13:100
   o. Reserve for future PID Control Files > MG14:0 or N14:0
   p. Reserve for future Messaging > N15
   q. Other Diagnostic Files > N16

4. PLC Programming Sub-routines: Divide PLC program into logical sub-routines. Each sub-routine shall contain the programming for a process or set of equipment. Examples of logical subroutines include:

   a. Ethernet Communication
   b. Process flow, level, and temperature signal scaling, totalizing and alarming
   c. Landfill leachate collection and removal system pump control
   d. Landfill leak detection system pump control
   e. Landfill crest pad building sump pump monitoring
   f. Landfill crest pad building miscellaneous control
   g. Leachate storage tank level measurement and leak detection
   h. Leachate collection and transmission line leak detection
   i. Leachate transfer pump control and flow totalization
   j. Combined sump pump control and leak detection
   k. Leachate transfer building miscellaneous control

5. PLC Program Documentation: Each PLC program shall be fully annotated with descriptive notations that define the functions associated with each program element. Provide the following minimum level of program documentation.

a. Each program element shall have a descriptive name associated.

b. Each program sub-routine and article associated within a major program shall be proceeded by a description of the sub-routine and article function.

c. Each major program shall be proceeded by a description of the program and a listing of the associated program sub-routines and articles.

6. The program documentation shall be developed using the PLC suppliers standard program documentation software. The PLC program documentation shall also include a complete cross reference listing of all program elements and their location within each program.

7. Program OIU to enable secured access to process set-points and control modes of operation. OIU shall be configured with process status display screens, set-point entry, equipment control mode, equipment runtime, flow totaling, alarm status, and alarm enable/disable screens. Process set-point and equipment control mode shall be implemented using RETURN ENTRY at the control panel mounted OIU.

8. Program OIU with three (3) security levels: engineer, operator, and system administrator. Engineer shall have access to all displays. Operator shall have access to all process status and alarm display screens but not control mode, alarm enable/disable, and set-point screens. Administrator shall have access to process status, and alarm enable/disable screens.

9. Configure and link OIU Main Menu, Sub-Menu and Data screens in a logical fashion allowing Operator(s) to logically move through each process control loop, with the ability to access data entry set-point and control modes.

10. Program and configure alarm screens for each alarm as described in Section 3.2 PLC Loop Descriptions of this Supplement. OIU alarm screens shall enable operator(s) to visually identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at local alarm display ONLY.

11. Program and configure Autodialer for each alarm as described in Section 3.2 PLC Loop Descriptions of this Supplement. Autodialer alarm options shall enable operator(s) to identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at Autodialer ONLY.

PLC & OIU Programming

PLC Standard Functions

1. General — PICS shall implement functions for the purpose of program standardization and minimum PLC application software capability. Functions may not be applicable to every program control loop or network.

2. PLC Standard Function No. 1 — Equipment Run Timers: For each equipment ON status input, track the runtime of the associated equipment item. Accumulate equipment runtime in tenths of hours using retentive timers with no timer reset due to equipment stoppage or power loss. Provide a command interface to allow reset or adjustment of equipment run time.

3. PLC Standard Function No. 2A — Equipment Failure Detection: Provide for each equipment item controlled by the PLC for which the PLC receives ON and AUTO or REMOTE status signals. Monitor for a fail condition when the unit is in the AUTO or REMOTE mode. A failure condition shall be activated when the unit is commanded by the PLC to run, and the PLC does not receive the unit's ON status signal after a 10-second delay period. When a failure condition is detected, inhibit the PLC run command to the unit. Reset the failure condition when the unit is taken out of AUTO or REMOTE mode.

4. PLC Standard Function No. 2B — Equipment Flow Failure Detection: Provide for each pump controlled by the PLC for which the PLC receives a PLC receives ON and AUTO or REMOTE, status and a PUMP DISCHARGE flow signal. Monitor for a fail condition when the unit is in the AUTO or REMOTE mode. A failure condition shall be activated when the unit is commanded by the PLC to run, and the PLC does not receive or maintain a positive flow value for a 10-second delay period. When a failure condition is detected, inhibit the PLC run command to the unit. Reset the failure condition when the unit is taken out of AUTO or REMOTE mode.

5. PLC Standard Function No. 3 — Analog Signal Scaling: Provide program logic to scale process analog signals to engineering units that correspond to the calibrated range of the field sensor. Store the scaled value in a PLC memory register for use in process control programming and for transmission to the OIU. Program PLC to monitor each analog input and ALARM in the event a process signal is out of the 4-20mA range. A process signal out-of-range ALARM condition shall prevent associated process control from taking place. Program PLC and OIU such that in the event a process signal is out-of-range, data point on OIU shall change to color YELLOW enabling personnel to know the data is incorrect.

6. PLC Standard Function No. 4 — Analog alarms: Provide the capability to detect and annunciate alarms, such as high-high, high, low, and low-low for analog process signals. The PLC shall continuously compare the scaled process signal to a set-point value stored in PLC register memory. If the scaled process signal exceeds the alarm set-point, the PLC shall initiate an alarm signal to the OIU system and to external annunciation equipment as noted in the Process Control Loop Descriptions. The analog alarm function shall also have the following capabilities:

   a. Provide time delays on all alarm set-points. When the PLC detects the scaled process signal exceeding set-point, initiate the alarm delay timer. At the end of the time delay, activate the alarm.

   b. Unless specified in the Loop Functional Descriptions, all analog alarms shall be self-resetting. The PLC shall reset the alarm condition when the scaled process signal value is within the set-point value plus a 2 percent dead band.

   c. Where noted in the Loop Functional Descriptions, provide alarm ENABLE/DISABLE program logic that respond to commands from the OIU. Suppress the activation of alarms when commanded to the DISABLE mode.

   d. Provide program logic to receive, and store in PLC register memory, alarm set-point commands from the OIU.

7. PLC Standard Function No. 5 — Discrete alarms: Provide adjustable alarm delay timers on all discrete alarm input signals monitored by the PLC. Upon detection of the alarm condition, the

PLC shall initiate the time delay. At the end of the time period, the PLC shall communicate the alarm condition to the OIU system and to external annunciation equipment as noted in the Process Control Loop Descriptions. The discrete alarm function shall also have the following capabilities:

a. Unless specified in the Loop Functional Descriptions, all discrete alarms shall be self-resetting. The PLC shall reset the alarm condition when the alarm input signal resets.

b. Where noted in the Loop Functional Descriptions, provide alarm ENABLE/DISABLE program logic that respond to commands from the OIU. Suppress the activation of alarms when commanded to the DISABLE mode.

8. PLC Standard Function No. 7 — Process Flow Totalizers: For all process flow signals provide program logic in the PLC to accumulate flow totals and flow total RESET. The totaled value stored in the PLC shall be transmitted to the OIU for display and historical logging. PLC shall increment flow total when pump ON status and minimum flow status is confirmed.

9. PLC Standard Function No. 8 — Pump Restart Time Delay: Provide adjustable delay timers in PLC program so as to prevent rapid restart of all pumps. An adjustable timer for each pump's AUTO start control logic, shall begin to countdown once a pump has stopped operating. PLC shall not execute AUTO start control logic for each pump until respective adjustable delay timer's accumulated value is equal to preset value of 30 seconds, except for Pumps P-205 and P-207, which will have a 10-second delay period.

10. PLC Standard Function No. 9 — Power Failure: Program PLC to prevent PLC from executing process equipment automatic control during a power failure condition.

PLC Loop Descriptions

Note: Loop Descriptions are typical for both Cell No. 1 and Cell No. 2 process equipment.

1. Landfill Leachate Collection and Removal System (Loops 101, 202 and 203). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Landfill leachate collection and removal system consists of one collection sump, high and low flow collection pumps, one common level sensor, two flow transmitters, pump discharge piping, and ancillary valves. Pumps shall extract leachate from landfill collection and removal system sump and pump leachate to an above grade leachate storage tank via an underground double walled containment pipe. PLC shall monitor discharge flow from each pump via flow transmitters installed in each pump's discharge line. PLC shall automatically compute total extracted leachate from sump. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement continuous monitoring of liquid levels inside landfill leachate collection and removal sump and provide automatic operation of high and low flow pumps. Program PLC to automatically operate pumps ON/OFF based upon liquid levels inside the landfill leachate collection and removal system sump. PLC shall automatically operate pumps ON/OFF in order to insure that liquid levels over landfill liner - as measured from the bottom of the sump - do not exceed 12-inches. The PLC shall be programmed to automatically turn off the low flow pump when the high flow pump is called to run.

c. AUTO Operation — Automatic operation requires operator(s) place each pump's respective ON-OFF-AUTO control switch (located at MCC) to AUTO mode. Pump operation and alarm set-points shall be entered at the control panel mounted OIU. The pumps shall operate between separate start and stop level set-points.

d. Process Control Set-points — Operator(s) shall enter the following control set-points at the control panel mounted OIU:

(1) High flow pump start level in inches

(2) Low flow pump start level in inches

(3) High flow pump stop level in inches

(4) Low flow pump stop level in inches

(5) Landfill leachate collection and removal system high-high level alarm in inches

(6) Landfill leachate collection and removal system high level alarm in inches

e. REMOTE Operation — None.

f. ON (manual) Operation — ON operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place high and low flow pump's respective ON-OFF-AUTO control switch (located at MCC) to ON mode.

g. Interlocks — Interlocks shall prevent operation of leachate collection and removal pumps in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the landfill crest pad building sump, leachate storage tank or combined sump.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Landfill leachate collection and removal system high-high level

(2) Landfill leachate collection and removal system high level

(3) Landfill leachate collection and removal system high flow pump fail

(4) Landfill leachate collection and removal system low flow pump fail

(5) Landfill leachate collection and removal system high flow pump flow fail

(6) Landfill leachate collection and removal system low flow pump flow fail

(7) Landfill leachate collection and removal system level signal fail

(8) Landfill leachate collection and removal system high flow pump flow signal fail

(9) Landfill leachate collection and removal system low flow pump flow signal fail

i. Runtime and Flow Totaling — Program PLC to implement runtime and flow totals for each leachate collection and removal system pump. PLC increments equipment runtime and process flows when respective pump ON status and minimum flow status is confirmed. PLC control logic shall be programmed to allow runtime and flow value reset and adjustment.

2. Landfill Leak Detection System (Loops 104 and 204). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Landfill leak detection system consists of one leak detection sump, collection pump, one level sensor, flow transmitter, pump discharge piping , and ancillary valves. Leak detection system pump shall extract leachate from landfill leak detection sump and pump this leachate to an above grade leachate storage tank via an underground double walled containment pipe. PLC shall monitor discharge flow from leak detection pump via flow transmitter installed in pump's discharge line. PLC shall automatically compute total extracted leachate from sump. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement continuous monitoring of liquid levels inside landfill leak detection system chamber and provide automatic operation of leak detection pump. Program PLC to automatically operate leak detection pump ON/OFF based upon liquid levels inside leak detection sump.

c. AUTO Operation — Automatic operation requires operator(s) place leak detection pump's ON-OFF-AUTO control switch (located at MCC) to AUTO mode and enter sump pump operation control set-points at the control panel mounted OIU. The landfill leak detection system pump shall operate between separate start and stop level set-points.

d. Process Control Set-points – Operator(s) shall enter the following control set-points at the control panel mounted OIU:

(1) Leak detection system pump start level in inches

(2) Leak detection system pump stop level in inches

(3) Landfill leak detection system high-high level alarm in inches

(4) Landfill leak detection system high level alarm in inches

e. REMOTE Operation — None.

f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place landfill leak detection pump's ON-OFF-AUTO control switch (located at MCC) to ON mode.

g. Interlocks — Interlocks shall prevent operation of leachate leak detection pump in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the landfill crest pad building sump, leachate storage tank, or combined sump.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Landfill leak detection system high-high level

(2) Landfill leak detection system high level

(3) Landfill leak detection system pump fail

(4) Landfill leak detection system pump flow fail

(5) Landfill leak detection system level signal fail

(6) Landfill leak detection system flow signal fail

i. Runtime and Flow Totaling — Program PLC to implement runtime and flow totals for landfill leak detection pump. PLC increments equipment runtime and process flows when respective pump ON status and minimum flow is confirmed. PLC control logic shall be programmed to allow runtime and flow value reset and adjustment.

3. Landfill Crest Pad Building Sump System (Loops 105, 205). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Landfill crest pad building sump system consists of a building sump, sump pump, level floats, leak detection sensor, and pump discharge piping. Sump pump extracts and pumps liquids from building sump to an above ground leachate storage tank. Landfill crest pad building sump pump operates ON/OFF based upon actuation of level floats inside the landfill crest pad building sump. PLC shall monitor leak detection sensor. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor sump float switches and provide automatic operation of landfill crest pad building sump pump between high and low level status. In the event of high-high level condition, PLC shall alarm. In the event of a leak alarm condition PLC shall prevent operation of landfill leachate collection and leak detection pumps.

c. AUTO Operation — Automatic operation requires operator(s) place sump pump's ON-OFF-AUTO control switch (located at MCC) to AUTO mode. The sump pump shall operate between start and stop levels. Operator(s) shall place sump leak detection ENABLE/DISABLE control switch (located at local sump control panel) to ENABLE leak detection control logic.

d. Process Control Set-points — None

e. REMOTE Operation — None

f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place sump pump's ON-OFF-AUTO control switch (located at MCC) to ON mode.

g. Interlocks — Interlocks shall prevent operation of landfill crest pad building sump pump in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the leachate storage tank, or combined sump.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Landfill crest pad building sump level high

(2) Landfill crest pad building sump level high-high

(3) Landfill crest pad building sump leak detected

(4) Landfill crest pad building sump pump fail

i. Runtime — PLC shall provide runtime for sump pump. PLC increments equipment runtime when respective pump ON status is confirmed. PLC control logic shall be programmed to allow runtime value reset and adjustment.

4. Leachate Storage Tank System (Loops 300, 301). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

a. General — Leachate storage tank system consists of an above grade tank with an outer steel wall, an interstitial leak detection chamber, ~~floating~~ cover, level sensors, leak detection sensors, and a transfer pump suction connection. Liquid is pumped to leachate storage tank from landfill leachate collection and leak detection pumps, landfill crest pad building sump pump, and combined sump. A level sensor located inside a stilling well - mounted inside the storage tank - provides continuous liquid levels measurements to PLC. This level sensor is backed-up by additional discrete level switches. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement continuous monitoring of liquid levels inside leachate storage tank. Level measurements shall be displayed at control panel inside landfill crest pad building and local control panel inside leachate transfer building. Program PLC to monitor level high-high and low-low switches which provide backup safety measurement and control for the continuous level sensor.

c. AUTO Operation — None.

d. Process Control Set-points:

(1) Leachate storage tank high-high level in inches

(2) Leachate storage tank high level in inches

(3) Leachate storage tank low level in inches

(4) Leachate storage tank low-low level in inches

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — Interlocks shall prevent operation of landfill leachate collection and removal and leak detection pumps, crest pad sump pump, and combined sump pump in the event of a leachate storage tank high-high level condition alarm condition. Interlocks shall prevent operation of transfer pump in the event of a storage tank low-low level condition.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Leachate storage tank high-high level

(2) Leachate storage tank high level

i. Runtime – None.

5. Combined Sump Pump System (Loops 107, 207). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

a. General — Combined sump pump system consists of a sump assembly with dual chambers (pump chamber and leak detection chamber), sump pump, level floats, and a leak detection sensor. Liquids from truck loading station, gravity drain to the sump pump chamber. Liquids from containment piping, gravity drain to leak detection chamber. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement automatic operation of combined sump pump. Combined sump pump shall operate ON/OFF based upon actuation of discrete floats mounted inside sump: sump high-high alarm level, sump pump high (start) level, sump pump low (stop) level and sump pump low-low (alarm) level. Program PLC to alarm when high-high level float switch is activated or low-low level float is actuated and sump pump ON status exists. Program PLC to monitor operation of leak detection sensor. Sump floats and leak detection sensor shall be hardwired to intrinsic safety relay modules.

c. AUTO Operation — Automatic operation requires operator(s) place combined sump pump ON-OFF-AUTO control switch (located inside transfer building) to AUTO mode. Sump pump shall operate between sump pump start and stop levels.

d. Process Control Set-points — None.

e. REMOTE Operation — None.

f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place sump pump ON-OFF-AUTO control switch (located inside transfer building) to ON mode.

(2) Pump selected to ON mode shall continue to operate until sump pump low-low level is reached.

g. Interlocks — Interlocks shall prevent operation of combined sump pump in the event of a leachate storage tank high-high level alarm condition. Interlocks shall prevent operation of landfill leachate collection and leak detection pumps, and landfill crest pad building sump pump in the event of a combined sump leak alarm condition.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Combined sump high-high level

(2) Combined sump low-low level

(3) Combined sump pump fail

(4) Combined sump leak detected

i. Runtime — Program PLC to provide runtime. PLC shall increment equipment runtime when pump ON status is confirmed. Implement PLC control logic necessary to allow local runtime value reset and adjustment.

6. Leachate Transfer Pump System (Loop 302). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

a. General — Leachate transfer pump system consists of a transfer pump with its suction line connected to leachate storage tank, discharge piping, flow meter, and a truck loading quick disconnect. System allows operator(s) to pump liquids from leachate storage tank to storage trucks. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor totalized flow from leachate storage tank to truck loading station for the purpose of determining amount of liquids being trucked off-site. Transfer pump operation is manual, with interlocks preventing transfer pump operation during a storage tank low-low level condition.

c. AUTO Operation — None

d. Process Control Set-points — None

e. REMOTE Operation — None

j. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place transfer pump ON-OFF control switch (located inside transfer building) to ON mode. Operator(s) shall monitor totalized flow as a means of determining duration of transfer operation.

f. Interlocks — Interlocks shall prevent transfer pump operation during a storage tank low-low level condition.

g. Alarms— Program PLC to monitor process and alarm for the following minimum conditions:

(1) Truck Loading Station flow signal fail.

(2) Transfer Pump low flow fail.

h. Flow Totaling — PLC shall provide flow totals for truck loading station. PLC control logic shall allow for flow reset and value adjustment.

7. Control Panel Power Monitoring System (Loop 219). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Control panel power monitoring system consists of a control relay mounted inside landfill crest pad building control panel. Power to landfill crest pad building control panel is monitored by this control relay. In the event of a power failure, control relay drops out removing input status to PLC. The PLC (which is powered by a UPS) senses the loss of signal, and prevents automatic operation of process equipment. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor power to control panel. In the event of a power failure, PLC program shall remove run command from all process equipment so as to prevent nuisance alarming and equipment failure. Program PLC to stagger start equipment after control power returns to normal.

c. AUTO Operation — None.

d. Process Control Set-points — None.

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — Interlocks prevent operation of equipment in the event of loss of power to control panel.

h. Alarms — Program PLC to monitor and alarm control panel power for following minimum conditions:

(1) Control Panel Power fail.

i. Runtime — None.

8. Crest Pad and Leachate Transfer Building Temperature Monitoring System (Loops 219, 220). P&ID drawings H-2-830854 sheets 1 & 2 of 4.

a. General — Crest pad and leachate transfer building temperature monitoring system consists of an ambient temperature transmitter which monitors the effective operation of building heating and cooling equipment. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor crest pad and leachate transfer building temperature levels and alarm in the event of temperature alarm condition signifying heating and cooling equipment failure.

c. Automatic Operation — None.

d. Process Control Set-points:

(1) Landfill crest pad building temperature level high alarm in degrees F

(2) Landfill crest pad building temperature level low alarm in degrees F

(3) Leachate transfer building temperature level high alarm in degrees F

(4) Leachate transfer building temperature level low alarm in degrees F

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — None.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Landfill crest pad building temperature level high alarm

(2) Landfill crest pad building temperature level low alarm

(3) Landfill crest pad building temperature signal fail alarm

(4) Leachate transfer building temperature level high alarm

(5) Leachate transfer building temperature level low alarm

(6) Leachate transfer building temperature signal fail alarm

i. Runtime — None.

9. Building General Alarm System (Loops 219, 220). Reference P&ID Drawing H-2-830854 sheet 1, 2 of 4.

a. General — Building general alarm system consists of alarm lights installed on the exterior wall of the landfill crest pad building and leachate transfer building which are operated by the PLC. Alarm light provides a visual method of notifying operator(s) of a general alarm condition.

b. Program — Program PLC to monitor all process loops and initiate general alarm in the event of an alarm condition. General alarm shall continue until process alarm condition is acknowledged by operator(s). Acknowledge shall be initiated at pushbutton or OIU on landfill crest pad building control panel. Program PLC to receive acknowledgement during an alarm condition, to turn off general alarm light, and be able to initiate a new general alarm in the event of a new and subsequent alarm condition.

c. AUTO Operation — None.

d. Process Control set-points – None.

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — None.

h. Alarms — (See previous loops).

i. Runtime — None.

OIU Displays and Layout

1. General — OIU shall be configured with process displays, data entry, runtime, and alarm screens. Process set-points and control modes shall be one-shot commands from the OIU.

2. Process display screens shall have a P&ID style of presentation. Displays shall include text for equipment and process identification. Data entry points and screens shall have a TABLE style of presentation.

3. Program OIU to enable secured access to process set-points and control modes of operation. OIU shall be configured with process status display screens, set-point entry, equipment control mode, equipment runtime, flow totaling, alarm status, and alarm enable/disable screens. Process set-point and equipment control mode shall be implemented using RETURN ENTRY at the control panel mounted OIU.

4. Program OIU with three (3) security levels: engineer, operator, and system administrator. Engineer shall have access to all displays. Operator shall have access to all process status and alarm display screens but not control mode, alarm enable/disable, and set-point screens. Administrator shall have access to process status, and alarm enable/disable screens.

5. Configure and link OIU Main Menu, Sub-Menu and Data screens in a logical fashion allowing operator(s) to logically move through each process control loop, with the ability to access data entry set-point and control modes as described in this document.

6. Program and configure alarm screens for each alarm as described in this document. OIU alarm screens shall enable operator(s) to visually identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at local alarm display ONLY. Acknowledge shall not be broadcast across network from OIUs.

7. Alarm Identifications:
    a. Process in Alarm and Unacknowledged: Flashing
    b. Process in Alarm and Acknowledged: Steady

8. Configure and link displays in a logical fashion allowing operator(s) to logically access all processes and select the following:
    a. IDF Process System Overviews (Displaying process levels, flows, and temperature for each system)
    b. Disposal Facility Equipment Runtime and Runtime Reset Display
    c. Disposal Facility Process Control Set-point Display(s)
    d. Disposal Facility Process Alarm Set-point Display(s)
    e. Disposal Facility Process Flow Totalization and Flow Totalization Reset Display
    f. Integrated Disposal Facility Alarm Display

Reference Management Directive TFC–034, Rev. A

USQ #04-0016-AA

CH2M HILL Hanford Group, Inc.	**Manual**	**Management Directive**
	Revision	**TFC-MD-034, REV A**
GRAPHIC PROCESS DISPLAY CRITERIA FOR HUMAN-MACHINE INTERFACES	**Page**	**292 of 3**
	Issue Date	**January 9, 2004**
	Effective Date	**January 12, 2004**
	Expiration Date	**March 1, 2004**
FUNCTIONAL AREA MANAGER:		**D. C. Lowe**
DOCUMENT OWNER:		**R. E. Larson**

1.0 PURPOSE AND SCOPE

The purpose of this management directive (MD) is to establish the requirements for standardized criteria for new graphic process displays (human-machine interfaces) that are being designed or acquired for process monitoring and control systems of CH2M HILL Hanford Group, Inc. (CH2M HILL) facilities and managed projects.

The requirements of this MD are applicable to new monitoring and control system designs (Human-Machine Interfaces) for CH2M facilities and to projects that have not completed an Acceptance Test Procedure (ATP). Application of the MD requirements to existing human-machine interfaces systems and human-machine interfaces systems with a completed ATP will be determined, planned, and performed in accordance with the resolution of PER-2003-4039.

2.0 IMPLEMENTATION

This management directive is effective on the date shown in the header and will remain in effect until a new Graphic Process Display Criteria for Human-Machine Interface Standard is issued.

3.0 DIRECTIVE

The following requirements that are based on the national standard ISA-S5.5-1985, "Graphic Symbols for Process Displays," are the Tank Farm Contractors (TFC) design requirement for new process monitoring and control systems (Human-Machine Interfaces).

3.1 General

The following general symbol usage standards apply:

1. The graphic process display will follow requirements specified in ISA-S5.5 standard.
2. The use of outline and solid (filled) symbol forms to indicate status is as follows:
   - An outline symbol form indicates an off, stopped, or nonactive state.

- A solid (filled) symbol form indicates an on, running, or active state.
- Status designation by use of solid or outline forms are particularly applicable to the rotating equipment and valves and actuators. In depicting valve position, use solid to show open (material flowing or active) and outline to show closed (material stopped or nonactive).
- A symbol may be partially filled or shaded to represent the characteristic of the contents of a vessel, e.g. level, temperature, etc.

3.2 Color

The following standards are to be applied to the application of color to process displays:

1. The following color application guidelines are to be followed:
   - The number of colors in one display should be limited to the minimum necessary (typically 4 or less) to satisfy the process interface objectives of the display.
   - Compatible color combinations should be used.
   - Use color as a redundant indictor along with text, symbol, shape, size, reverse video, blinking, and intensity coding to preserve communication with individuals having limited color perception.
   - Colors are not to be used to indicate quantitative value.
2. Colors are to be assigned consistent with Tables 1-4.

Table 1. Unique Component Colors (e.g., Leak Detectors, Tanks)

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	White
In Service – Selected (No Alarm)	Green
Alarming (Unacknowledged)	Flash Red
Alarm (Acknowledged)	Solid Red
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)
Caution Alarm (Acknowledged)	Solid Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

Table 2. Pipe Colors

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	White
In Service – Selected (No Alarm)	Grey
In Service – Selected (with Air or Fluid Flow)	Green
Encasement Leak Detector Alarming (Unacknowledged)	Red with Flashing Text
Encasement Leak Detector Alarm (Acknowledged)	Solid Red
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)
Caution Alarm (Acknowledged)	Solid Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

Table 3. Valves Port Colors

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	Grey*
In Service – Selected/Operable: Open Port (No Alarm)	Green
In Service – Selected/Operable: Shut Port (No Alarm)	White*
In Service – Operating: Transition	Yellow (All Ports)
Valve Position Alarm (Unacknowledged)	Flash Red
Valve Position Alarm (Acknowledged)	Solid Red
Caution Alarm	Flash Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

* The grey color used for the unselected valve is for contrast with an unselected pipe (white), which assists the operator in distinguishing the pipe from the valve (operator influence from display screen tests). The white color used to identify a shut port on a valve is in contrast with the valve open ports (green) and with the selected pipe (grey) which assists the operator in distinguishing the pipe from the valve.

Table 4. Pump Colors

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)		
State	**Fill Color**	**Text**
Out of Service	Black	--
In Service – Unselected	White	--
In Service – Selected: Pump Off and Power Off (No Alarm)	Grey	Stopped
In Service – Selected: Pump Off and Power On (No Alarm)	Yellow	Stopped
In Service – Selected: Pump On (Rotating)	Green	Running
Pump Alarm (Unacknowledged)	Flash Red	Stopped
Pump Alarm (Acknowledged)	Solid Red	Stopped
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)	Caution

4.0 RECORDS

No records are generated in the performance of this management directive.

5.0 REFERENCES

Instrument Society of America (ISA) S5.5-1985, “Graphic Symbols for Process Displays.”

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2										
Rev	**Tag 1**	**Tag 2**	**Tag 3**	**Tag 4**	**System Description**	**Setpoint Description**	**Drawing**	**Process Ranges**	**Eng. Units**	**Comments**
	Area	**Process**	**ISA**	**Eqt #**						
1	219(Y)	LH	LAHH	101	Leachate Collection and Removal System	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	12.0 inches above LCRS 50' x 50' sump floor.	Inches	Actuate elevation 673.90
1	219(Y)	LH	LAH	101	Leachate Collection and Removal System	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	11.0 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.82, activates slightly above elevation that LCRS High Flow pump On activates
1	219(Y)	LH	LAHH	104	Leak Detection System	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	12.0 inches above LDS sump floor	Inches	Actuate elevation 671.90
1	219(Y)	LH	LAH	104	Leak Detection System	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	11.0 inches above LDS sump floor	Inches	Actuate elevation 671.82
1	219(Y)	LH	FALL	202	Leachate Collection and Removal System Low Flow Pump	Low Flow Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	5	gpm	Half of Design Flowrate of 10 gpm
1	219(Y)	LH	FALL	202	Leachate Collection and Removal System Low Flow Pump	Low Flow Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	180	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	LAM	202	Leachate Collection and Removal System	Low Flow Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	6.00 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.40
1	219A	LH	LAL	202	Leachate Collection and Removal System	Low Flow Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	0.65 inch above LCRS 50' x 50' sump floor	Inches	Actuate elevation 672.95

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2										
Rev	**Tag 1**	**Tag 2**	**Tag 3**	**Tag 4**	**System Description**	**Setpoint Description**	**Drawing**	**Process Ranges**	**Eng. Units**	**Comments**
	Area	**Process**	**ISA**	**Eqt #**						
1	219E	LH	LAL	202	Leachate Collection and Removal System	Low Flow Pump Stop Level Setpoint	H-2-830854 sheet 3 of 4	1.75 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.04
1	219(Y)	LH	LAM	203	Leachate Collection and Removal System	High Flow Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	10.8 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.80
1	219A	LH	LAL	203	Leachate Collection and Removal System	High Flow Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	4.25 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.22
1	219E	LH	LAL	203	Leachate Collection and Removal System	High Flow Pump Stop Level Setpoint	H-2-830854 sheet 3 of 4	9.25 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.67
1	219(Y)	LH	FALL	203	Leachate Collection and Removal System High Flow Pump	High Flow Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	74	gpm	Half of Design Flowrate of 147 gpm
1	219(Y)	LH	FALL	203	Leachate Collection and Removal System High Flow Pump	High Flow Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	40	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	FALL	204	Leak Detection System	Leak Detection Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	1	gpm	Half of Design Flowrate of 2 gpm

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2										
Rev	**Tag 1**	**Tag 2**	**Tag 3**	**Tag 4**	**System Description**	**Setpoint Description**	**Drawing**	**Process Ranges**	**Eng. Units**	**Comments**
	Area	**Process**	**ISA**	**Eqt #**						
1	219(Y)	LH	FALL	204	Leak Detection System	Leak Detection Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	880	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	LAM	204	Leak Detection System	Leak Detection Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	10.8 inches above LDS sump floor	Inches	Actuate elevation 671.80
1	219(Y)	LH	LAL	204	Leak Detection System	Leak Detection Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	5.25 inches above LDS sump floor	Inches	Actuate elevation 671.34
1	219(Y)	LH	TAH	219	Crest Pad Building	Temperature High Alarm Setpoint	H-2-830854 sheet 1 of 4	90	Fahrenheit	AC will allow 85 degrees F max temp
1	219(Y)	LH	TAL	219	Crest Pad Building	Temperature Low Alarm Setpoint	H-2-830854 sheet 1 of 4	45	Fahrenheit	Heater will allow 50 degrees F low temp
1	219(Y)1	LH	TAH	220	Transfer Building	Temperature High Alarm Setpoint	H-2-830854 sheet 1 of 4	90	Fahrenheit	AC will allow 85 degrees F max temp
1	219(Y)1	LH	TAL	220	Transfer Building	Temperature Low Alarm Setpoint	H-2-830854 sheet 1 of 4	45	Fahrenheit	Heater will allow 50 degrees F low temp
1	219(Y)201	LH	LAHH	301	Leachate Storage Tank	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	74.4 inches above tank floor at wall	Inches	Actuate elevation 728.33, Activates at same elev as Hardware HH switch (at max operating capacity 6.2'), allowing 2 ft of freeboard

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2										
Rev	**Tag 1**	**Tag 2**	**Tag 3**	**Tag 4**	**System Description**	**Setpoint Description**	**Drawing**	**Process Ranges**	**Eng. Units**	**Comments**
	Area	**Process**	**ISA**	**Eqt #**						
1	219(Y)201	LH	LAH	301	Leachate Storage Tank	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	Activates at 24 inches above tank floor at wall	Inches	Actuate elevation 724.13, reserving 4.2 ft operating capacity for design storm event
1	219(Y)201	LH	LAL	301	Leachate Storage Tank	Low Alarm Level Setpoint	H-2-830854 sheet 1 of 4	Activates just before falling water level reaches Hardware LL (7.8 inches above tank floor at wall) setpoint	Inches	Actuate elevation 722.78 (approximately 1 - 9,000 gallon truck load above the Low Low Setpoint)
1	219(Y)201	LH	LALL	301	Leachate Storage Tank	Low Low Alarm Level Setpoint	H-2-830854 sheet 1 of 4	6 inches above tank floor at wall	Inches	Activates at same elev as Hardware LL switch, activates just before falling water level reaches 6 inches above tank floor (722.63), assuring transfer pump does not run dry
1	219(Y)1	LH	FALL	302-1	Leachate Transfer Pump	Transfer Pump Low Flow Fail Setpoint	H-2-830854 sheet 1 of 4	125	gpm	Half of Design Flowrate at 250 gpm
1	219(Y)1	LH	FALL	302-1	Leachate Transfer Pump	Transfer Pump Low Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	10	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2										
Rev	**Tag 1**	**Tag 2**	**Tag 3**	**Tag 4**	**System Description**	**Setpoint Description**	**Drawing**	**Process Ranges**	**Eng. Units**	**Comments**
	Area	**Process**	**ISA**	**Eqt #**						
(Y) = A for Cell No. 1 (Y) = E for Cell No. 2				For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4. For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.						

DIVISION 14 (NOT USED)

DIVISION 15 (NOT USED)

SECTION 15021 – HIGH DENSITY POLYETHYLENE (HDPE) PIPE SCHED. B

Part 1 – General

Summary

This section is for furnishing and installing leachate piping and associated components.

References

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Recognizing some requirements of the references cited below may not be applicable, the Engineer shall judge the applicability of compliance with the references not specifically addressed herein. In the event of a conflict between the text of this Specification and the references cited herein, the text of this Specification shall take precedence or as directed by the Engineer.

ASTM INTERNATIONAL (ASTM)

ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials.
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D2513	Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F714	Standard Specification for Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter.

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192.285	Plastic pipe; qualifying persons to make joints.

Description

Pipe: This section includes all high density polyethylene (HDPE) pipe used in the cells including but not limited to:

Leachate collection piping on floor and cleanout access pipes on the slopes of the trench.

Leachate discharge piping, leak detection piping, and associated riser pipes.

Double containment piping outside the cell (e.g., leachate force main and drain lines) and elsewhere as shown on the Drawings.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's design guidance that includes spacer maximum spacing, attachment method, orientation and material type.

Manufacturer's certificates of compliance for all pipe and fittings. Certificates shall acknowledge that pipe and fittings meet the requirements of the Specifications.

Descriptive literature about the fusion equipment to be used and certification from the pipe supplier or manufacturer that the joining technician(s) is certified and experienced in heat fusion joining of HDPE pipe. Certification shall contain the following minimum information:

Name of technician.

Date of certification.

Statement by the pipe supplier that the technician is certified in the means and methods of joining the supplier's pipe and fittings using butt fusion techniques.

Make(s) and model(s) of fusion equipment the technician is certified to join pipe with.

Submittals–Approval Not Required

Information/Record (IR):

Catalog and manufacturer's data sheets for HDPE pipe and fittings.

Catalog and manufacturer's data sheets, electrofusion couplers, mechanical cutters, and appurtenances.

Part 2 – Products

All HDPE pipe and fittings shall conform with additional applicable requirements defined in the Piping Schedule in Section 15060, PIPING-GENERAL.

HDPE Pipe

Resin: HDPE pipe shall be manufactured from first quality extra-high molecular weight, high density polyethylene resin containing no more than 2 percent clean recycled polymer by weight. Resin shall meet or exceed the requirements of ASTM D3350 for PE3408 material with a cell classification of 345434C or higher. Alternate cell classifications are acceptable if one or more of the 6 numbers in the cell classification is greater than the minimum. Pipe shall be rated PE3408. Pipe and fittings shall be in compliance with schedule attached as supplement (see Attachment 1, HIGH DENSITY POLYETHYLENE (HDPE) PIPE) or as shown on the Drawings.

Quality: The pipe shall have uniform wall thickness and shall be uniform in color, opacity, density, and other physical properties. Pipe shall be homogeneous throughout and free of visible cracks, holes, blisters, bubbles, undispersed raw materials, or any contamination by foreign matter. Any pipe with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

Form: Pipe may be supplied in a continuous extruded seamless piece or in sections.

Manufacturer's Certificates of Compliance:

The manufacturer shall submit a Certificate of Compliance of the HDPE pipe supplied for the IDF project, which will include that the pipe is grade PE3408 and the identity of the cell classification per ASTM D3350.

HDPE pipe SDR shall be as indicated on the Piping Schedule in Section 15060, PIPING-GENERAL.

Fittings:

Fittings shall conform to the requirements of Article HDPE PIPE of this section, shall be compatible with components of the double containment system, and HDPE manholes where required.

Polyethylene fittings shall be from the same manufacturer as the pipe (or approved equal), molded or fabricated from polyethylene pipe and shall have the same or numerically smaller SDR than pipe connecting to the fitting. Fittings shall follow requirements in Attachment 1.

All reducing tees shall be factory molded if available as a standard item by any manufacturer having pipe meeting this section. If not available as a standard item, branch saddle reducing tees shall be used. Reducers shall be shop manufactured. Fabricated branch connections will not be allowed if branch saddle connections are listed in the manufacturer's catalog.

All molded polyethylene fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. All fabricated polyethylene fittings shall have the same or higher pressure rating as the adjoining pipe when installed in accordance with the manufacturer's recommendations.

Double Containment Pipe

Pipe Materials: Both carrier pipe and containment pipe shall meet the requirements of Article HDPE PIPE of this section.

Configuration: Double containment pipe shall consist of a carrier pipe installed within a containment pipe. All pipe and fittings shall provide an annular space between the carrier and containment pipes to accommodate possible flow of fluid from the carrier pipe.

Support Spacers: Support spacers shall be manufactured from nonmetallic, corrosion-resistant material with the same or better chemical compatibility properties as the HDPE pipe. Spacer intervals and attachment method to the carrier pipe shall be in accordance with the manufacturer's recommendations. Spacing shall be reduced if required to maintain the annulus between the carrier and containment pipes and shall be positioned to allow for unrestricted passage of possible flow of fluid from the carrier pipe. Spacers shall be chamfered at both ends to allow for removal of carrier pipe. Materials and systems used to secure the spacers to the pipe shall have the same or better chemical compatibility properties as the HDPE pipe.

Fittings: Fittings shall conform to the requirements of Article HDPE PIPE of this section and shall be compatible with components of the single wall HDPE pipe where required (except for trench riser pipes).

Slotted Pipe

Leachate Collection Piping: Leachate collection and leak detection piping on the floor of the cells and elsewhere as shown on the Drawings shall be slotted. Cleanout access pipes and leachate transmission piping shall not be slotted.

In addition to meeting all other requirements of this section, slotted pipe shall have slots 0.128 inch wide and 1.25 inches long, in five places equidistant around the pipe for 12-inch and 18-inch diameter pipes. Slots shall provide a minimum of 9 square inches of open area per linear foot of pipe for 12-inch and 18-inch diameter pipes. For 3-inch diameter slotted pipe, the pipe supplier shall propose a configuration of 0.128-inch wide slots that provides a maximum of 7 square inches of open area per linear foot of pipe. Slotted pipes shall be free of cutting debris from the slot cutting process.

Perforated pipe with circular drill holes is not allowed.

Part 3 – Execution

General

All HDPE pipe and fittings shall be installed in conformance with applicable code requirements referenced in Section 15060, PIPING-GENERAL.

Dimensions

Piping dimensions shown on the Drawings are approximate. It is the Construction General Contractor's responsibility to furnish and install piping of the proper dimensions, which will properly fit with the connecting elements, pipes, fittings, pumps, etc.

Installation

Pipe shall be handled and stored in such a manner as to ensure a sound, undamaged condition.

Pipe shall be cut in a neat, workmanlike manner using a mechanical cutter that will not damage the pipe.

Joining of HDPE pipe to HDPE pipe shall be accomplished by thermal butt fusion joint; no solvent welding or adhesive welding shall be allowed. Electrofusion couplings shall only be allowed when access to piping is restricted and only as approved by the Engineer. Slotted leachate collection piping shall be joined with thermal butt fusion joints. Pipe shall be joined per ASTM D2657 and manufacturer's recommendations.

Single butt fusion welds shall be used to create pipe sections as long as practicable. Fabricated pipe sections and fittings may be joined by the double butt fusion process.

During installation, the pipe shall not be pulled across sharp projections that could cause gouges, kinks, or other types of damage. To minimize "snaking" due to thermal expansion, protect pipe from direct sunlight, or limit unrestrained length of pipe during installation.

Allowance for Thermal Expansion/Contraction:

HDPE has a coefficient of thermal expansion of 1.2 x 10-4 ft/ft/deg F. Buried HDPE pipe shall be installed with excess length between anchor points such that contraction caused by temperature drop to 40 degrees F will produce the length of pipe between two points shown on the Drawings. Amount of excess pipe depends on temperatures of pipe at the time of installation, according to Table 1 for buried piping:

TABLE 1

Installation Temperature (degrees F)	Excess Pipe Length (in./100 ft)
50	1.4
60	2.9
70	4.3
80	5.8
90	7.2
100	8.6
120	11.5

Installation temperature is of the pipe material and not ambient air temperature. Measure installation temperature with a strip thermometer laid directly on the pipe. Verify temperate and excess pipe length required immediately before burial.

Placement of Buried Pipes:

Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.

The pipe shall not be dropped into the trench. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe. The full length of the pipe shall be firmly bedded on the trench bottom.

The pipe shall be bedded in such a way as to maintain grade with a tolerance of -0.0 percent, +0.5 percent with a uniform, constant grade and no localized low spots.

Pipe Base and Pipe Zone:

As specified in Section 02320, TRENCH BACKFILL.

Keep trench dry until pipe laying and joining are completed.

Prevent foreign material from entering pipe during placement.

Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.

After joint has been made, check pipe alignment and grade.

Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

Prevent uplift and floating of pipe prior to backfilling.

Place pipe along pipe runs starting at one end and moving towards the other to avoid joints that will not be feasible with butt fusion.

Tolerances: Horizontal position of pipe centerline on alignment around curves maximum variation of 1.0 foot from position shown.

Pipe Cover:

Minimum 2 feet 6 inches from finished elevation of overlying material, unless otherwise shown.

Temporarily close pipe ends as required to avoid introducing dirt or other foreign material into the pipe.

Trenching and backfilling operations shall be conducted in accordance with the requirements of Section 02320, TRENCH BACKFILL, for utility trenching. If trenching is used, underlying materials shall not be disturbed or damaged in anyway. Backfilling operations shall ensure that no voids are present under or at the sides of the pipe. Backfill shall initially be placed to the top of the pipe, then hand compacted. The remainder of the trench shall then be backfilled and compacted by hand or with a power tamper only.

On the floor of the cell, pipe may be placed directly on geosynthetic layers prior to placing drainage gravel. Placement of gravel around pipes shall be by hand unless otherwise approved by the Engineer. Placement operations shall ensure that no voids are present under or at the sides of the pipe. Placement operations shall not disturb the position of the pipe.

Where flanged joints are used, the bolts shall be evenly torqued using a crossing pattern to gradually tighten the lug nuts. Torque values shall be as recommended by the flange manufacturer. Flanged joints shall be retorqued after one hour or more has passed. Apply anti-seize compound on all threaded surfaces before tightening.

Flaws (minor imperfections, damaged areas, etc.) in HDPE pipe with a depth of 10 percent or less of the nominal wall thickness will not require repair or replacement. In double containment systems, carrier pipe with flaws deeper than 10 percent of the wall thickness shall be replaced. Single pipe or containment pipe with flaws between 10 and 25 percent of the wall thickness shall be repaired in accordance with the pipe manufacturer's recommendations. The Construction General Contractor shall certify in writing that the repaired area will have material properties that meet or exceed those of intact pipe. Any pipe with flaws deeper than 25 percent of the nominal wall thickness shall be rejected.

All valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

Butt-fusion shall be performed in accordance with pipe manufacturer's recommendations as to equipment and technique.

Weld Beads: Remove internal weld beads from the side slope risers and horizontal sections of slotted pipe where the LCRS and LDS pumps will be placed and the horizontal and vertical sections of the LCRS level transducer pipe. Remove all plastic debris from inside pipe.

Slotted Pipe: Slotted pipe shall be cut and joined so that full contact is made around the entire circumference of the weld. Partial weld contact because of joints through a slot row is not acceptable.

Locator Ribbon

Locator ribbon shall be installed as specified in Section 02320, TRENCH BACKFILL.

Identification Ribbon

Underground pipelines, except for pipelines inside the Phase I liner limits, shall be identified by use of a plastic ribbon or stencil no less than 3 inches in width with a message printed on the ribbon, which identifies the actual pipeline contents. Marking tapes or stencils shall be placed on existing lines where they are exposed by trenching operations. The ribbon shall be wrapped around the pipeline at no less than 1 wrap per 3 feet of run. The plastic ribbon/stencil shall be color coded in accordance with the Piping Schedule.

Cleaning

Clean all piping as required in Section 15060, PIPING-GENERAL, to remove all foreign materials including dirt, grease, and other matter.

Construction Quality Control (Acceptance Testing)

Per Section 15992, PIPING LEAKAGE TESTING, and the Piping Schedule in Section 15060, PIPING-GENERAL.

END OF SECTION 15021

Attachment 1, High Density Polyethylene (HDPE) Pipe

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
Pipe		Pipe SDR shall be AS INDICATED ON THE Piping Schedule in Section 15060, PIPING-GENERAL. Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin. Pipe wall thickness shall reflect the required SDR* and diameter, as shown in Table 8, ASTM F714. *SDR: standard dimension ratio = OD/thickness
Fittings	6-inch and smaller 8-inch and larger	Molded fittings, butt fusion joined, conforming to ASTM D3261. Molded if manufactured as a standard item or same as pipe, butt fusion joined, conforming to ASTM D3350.
Electrofusion		Rigid, straight coupler constructed from injection-
Couplers		molded polyethylene with embedded heating coils as manufactured by Central Plastics; or equivalent.
Flanges		ASTM A351 Type 316/CF8M stainless steel, 150-pound, ANSI B16.5 standard, convoluted back-up ring with one-piece polyethylene molded flange adaptor ends, same rating pressure as pipe.
Bolting		Stainless steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts. Manufacturer's recommended anti-seize compound on all threads. Washers shall be same material as bolts.
Gaskets		Flat ring, 1/8-inch Viton.

SECTION 15022 – HIGH DENSITY POLYETHYLENE MANHOLES SCHED. B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials.
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fitting Materials.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Product data sheets for make and model.

Complete catalog information, descriptive literature, specifications, construction drawings, and identification of materials of construction.

Provide calculations indicating diameter and wall thickness of each manhole is acceptable per design criteria specified.

Submittals–Approval Not Required

Information/Record (IR): Submit results of manhole leakage testing.

Part 2 – Products

HDPE Manholes

The manhole shall be manufactured by the fabrication of high density polyethylene (HDPE pipe). The riser shall be made of HDPE plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D1248. The cell classification shall be 345434C per ASTM D3350. Alternate cell classifications are acceptable if one or more of the six numbers in the cell classification are greater than the minimum. Pipe shall be rated PE3408.

Flatstock shall meet or exceed ASTM D1248 requirements for Type III, Class C, Category 3, Grade G5.

HDPE pipe and flatstock used to fabricate the HDPE manhole shall meet all product requirements of Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE. HDPE pipe for 76-inch diameter manhole shall be SIDR 39.0. HDPE pipe for 42-inch diameter manhole shall be SDR 21.

Welding rods, connecting couplings, pipe collars and other materials, as required to complete the installation, shall be of the same plastic as the flatstock.

Piping and appurtenances shall meet the requirements of Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and Section 15060, PIPING–GENERAL.

Access hatch shall be precast vault lid with spring-assisted galvanized plate cover with locking latch; cover shall be weather tight with channel drain. Utility Vault Model 77-2-332P; or approved equal.

Wall thickness and diameter of each manhole shall be verified assuming the following design criteria:

Dimensions specified and depth of manholes identified on Drawings.

Lateral load transmitted to 76-inch diameter manhole from concrete ring footing shown on Drawing H-2-830850.

Weight of precast utility vault equal to 4,020 pounds.

Load on utility vault equal to 100 pounds per square foot (vault will not have traffic loads).

No groundwater forces acting on 76-inch diameter manhole.

42-inch manhole full of water.

Part 3 – Execution

Fabrication

Inlet and outlet piping shall be installed as shown on Drawings by fabricator prior to delivery to site.

The manhole shall be fabricated with the minimum number of welds practical.

All welds shall be heat fused in accordance with manufacturer's recommendations on equipment specifically designed for welding thermoplastic sheets or extrusion welded by precertified welders.

Installation

Manholes shall be handled and stored according to manufacturer's recommendations and in such a manner as to ensure a sound undamaged condition.

Excavation and backfilling operations shall be conducted in accordance with Section 02316, EXCAVATION, and Section 02315, FILL AND BACKFILL.

Joining of HDPE field piping to HDPE manhole pipe stubouts shall be done by thermal butt or socket fusion, no solvent or adhesive welding shall be allowed. HDPE welding shall be by qualified and approved welders as identified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Install piping, appurtenances, and pipe hangers and supports in accordance with Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and Section 15060, PIPING-GENERAL.

Install access hatch in accordance with Drawings.

Construction Quality Control – Leakage Testing

After all HDPE manhole pipe stubout connections have been completed for inner and outer HDPE manholes, and prior to backfilling, perform separate leakage tests for inner and outer manholes. Each manhole shall be completely filled with water and no leaking shall be allowed from any HDPE joints for a period of 8 hours. General Construction Contractor shall provide necessary shoring during leakage testing of outer manhole per manufacturer's recommendations to compensate for lack of backfill.

END OF SECTION 15022

SECTION 15060 – PIPING-GENERAL SCHED. B

Part 1 – General

Summary

This section is for furnishing and installing leachate piping and associated components.

References

The following is a list of standards, which may be referenced in this section and any supplemental Data Sheets:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.3	Malleable Iron Threaded Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.11	Forged Fittings, Socket-Welding and Threaded
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B16.42	Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B36.10M	Welded and Seamless Wrought Steel Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C153/ A21.53	Ductile-Iron Compact Fittings 3 Inches Through 24 Inches and 54 Inches Through 64 Inches, for Water Service

ASTM INTERNATIONAL (ASTM)

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM D1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

ASTM D2467	Standard Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product data sheets, complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.

Qualifications:

Solvent Welders: List of solvent welders and current test records for solvent welder(s) for field solvent welding.

Submittals–Approval Not Required

Information/Record (IR): Manufacturer's Certification of Compliance.

Part 2 – Products

Piping

High Density Polyethylene Piping:

As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Others as specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

Diameters Shown:

Standardized Products: Nominal size.

Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.

Joints

Flanged Joints:

Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.

Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

Threaded Joints:

NPT taper pipe threads in accordance with ANSI B1.20.1.

Mechanical connections of high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of products as specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.

Gasket Lubricant

Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

Double Wall Containment Piping System

As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Flexible Hose

Flexible hose required for connection of leachate pump discharge piping to crest pad piping manifold and at truck loading station shall be Royalflex, vinyl nitrile by Boston Industrial Products, or equal, rated at a minimum of 125 psi.

A male and female quick-connect coupling shall be factory or shop installed on each length of flexible hose with stainless steel banding. 1-1/2-inch quick connect couplings for flexible hose and leachate pump discharge piping within the slope riser pipe shall be fiberglass-filled polypropylene, 3-inch quick connect couplings shall be stainless steel, each size shall include stainless steel rings, arms, and pins. Stainless steel quick connects shall have minimum pressure rating of 150 psig. Anti-galling compound shall be used for threaded stainless steel connections.

Vent And Drain Valves

Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

Fabrication

Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

Finishes

Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

Galvanizing:

Hot-dip applied, meeting requirements of ASTM A153.

Electroplated zinc or cadmium plating is unacceptable.

Stainless steel components may be substituted where galvanizing is specified.

Locator Ribbon

As specified in Section 02320, TRENCH BACKFILL.

Insulation

Piping:

Combined Sump (Discharge Piping Only) and Piping Requiring Heat Trace:

Material: Flexible elastomeric pipe insulation, closed cell structure, 3/4 inch thick.

Temperature Rating: Minus 40 degrees F to 180 degrees F.

Nominal Density:

- 6 pcf.
- Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft2 degrees F at 75 degrees F per ASTM C177 or ASTM C518.
- Minimum water vapor transmission of 0.10 perm-inch per ASTM E96.
- Seal joints with manufacturer's adhesive.

Flame Spread Rating: Less than 25 per ASTM E84.

Manufacturers and Products:

Rubatex: R-180-FS.

Armstrong: Armaflex AP.

Piping and Insulation Cover: Aluminum jacket 0.016-inch thick.

Part 3 – Execution

Examination

- Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

Preparation

Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

Installation-General

- Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

Remove foreign objects prior to assembly and installation.

Flanged Joints: Install perpendicular to pipe centerline.

Bolt Holes:

Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.

Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.

Raised-Face Flanges:

Use flat-face flange when joining with flat-faced ductile or cast iron flange.

Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

Threaded flanged joints must be shop fabricated and delivered to jobsite with flanges in-place and properly faced.

Threaded and Coupled Joints:

Conform with ANSI B1.20.1.

Produce sufficient thread length to ensure full engagement when screwed home in fittings.

Countersink pipe ends, ream and clean chips and burrs after threading.

Make connections with not more than three threads exposed.

Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

High Density Polyethylene Piping: As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Installation-Exposed Piping

Piping Runs:

Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

Piping Clearance (unless otherwise shown):

Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inches, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

From Adjacent Work:

Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

Head room in front of openings, doors, and windows shall not be less than the top of the opening.

Do not install piping containing liquids or liquid vapors in transformer vaults.

Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

Installation-Double Wall Containment Piping System

Install as specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Installation-Buried Pipe

Placement: In accordance with Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Slab, Floor, Wall, and Roof Penetrations

Application and Installation: As shown on Drawings.

Wall Pipe Installation: Support wall pipes securely by framework to prevent contact with reinforcing steel and tie wires.

Branch Connections

Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

Threaded Pipe Tap Connections:

Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.

Limitations: Threaded taps in pipe barrel are unacceptable.

Cleaning

Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

The up-slope riser pipe and slotted pipe shall be cleaned internally after deburring by pulling cotton pillows attached to ropes through pipe repeatedly until no debris comes out of pipe with pillow. Water flushing shall not be permitted. Pipe ends shall be covered after fabrication and at the end of shifts to avoid foreign materials from entering pipe.

If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

Field Finishing

Notify Construction Manager at least 3 days prior to start of any surface preparation or coating application work.

Locator Ribbon

Locator ribbon shall be installed as specified in Section 02320, TRENCH BACKFILL.

Pipe Identification

Exposed Piping

In general, all exposed piping shall be color coded and identified in accordance with ANSI A-13-1. It is the intent of this standard that the identification method of aboveground piping is by English text that allows the contents to be readily identified. Flow direction should be also shown by arrows.

All piping and equipment shall be identified in accordance with established site standards.

In addition to the requirements specified herein, all pipelines and standard equipment shall be color coded and identified with beaded chain or steel cable stainless steel tags displaying the pipe or equipment number as shown on the Drawings. The tags shall be fabricated from 300 series austenitic stainless steel metal strips 3/4 inch wide, 24-gauge minimum thickness, with 3/16-inch high letters stamped on the metal surface. Any pipes entering or leaving a building shall be tagged adjacent to floor or wall penetration. The tags shall be attached to the pipe or austenitic equipment with austenitic stainless steel bead chain or austenitic stainless steel cable. When tagging valves, the bead chain shall be attached to the valve stem or yoke.

Construction Quality Control – Leakage Testing

As specified in Section 15992, PIPING LEAKAGE TESTING.

Supplements

Supplement 1—Polyvinyl Chloride (PVC) Pipe and Fittings.

Supplement 2—Galvanized Steel Pipe and Malleable Iron Fittings.

Supplement 3—Piping Schedule.

END OF SECTION 1506

1 **Polyvinyl Chloride (PVC) Pipe & Fittings**

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
Bolting	All	ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/ A194M Grade 8M hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Lubricant	All	Teflon Tape.

Galvanized Steel Pipe & Malleable Iron Fittings

Item	Size	Description
Pipe		Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	2" and smaller	Schedule 80.
	2-1/2" through 6"	Schedule 40.
Joints	All	Threaded or flanged at valves and equipment.
Fittings		Threaded: 150- or 300-pound galvanized malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded malleable iron, ASTM A197 or A47, 300-pound WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Bolting		Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
Thread Lubricant	2" & smaller	Teflon tape or joint compound that is insoluble in water.

Piping Schedule Legend

Service Code	
LH	Leachate Handling
LHCP	Leachate Handling Containment Pipe
LT	Leachate Transfer
LTCP	Leachate Transfer Containment Pipe
Service	
CPB	Crest Pad Building
CS	Combined Sump
IC	In-Cell
LTB	Leachate Transfer Building
OC	Outside-Cell
TL	Truck Loading
Exposure	
BUR	Buried
EXP	Exposed
SUB	Submerged
Material	
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene
PVC	Polyvinyl Chloride
Pressure Test	
H	Hydrostatic
P	Pneumatic
NA	Not Applicable
Joint Type	
BF	Butt Fused
FL	Flanged
SW	Solvent Weld
TH	Threaded
QC	Quick Connect

Piping Schedule

Service Code	Service	Size(s) (In.)	Exposure	Piping Material	Joint Type	Specification Section	Test Type	Test Pressure (psi)[1]	Remarks
LH	IC	All	BUR	HDPE	BF, QC	15021	H	65* LCRS–Low Flow 100* LCRS–High Flow 65* LDS	SDR 11
LHCP	IC	3”	BUR	HDPE	BF	15021	P	8	SDR 11, slotted portion of pipe not to be tested
LHCP	IC	12” & 18”	BUR	HDPE	BF	15021	P	8	SDR 17, slotted portion of pipe not to be tested
LH	CPB CS	All	EXP	PVC	SW, FL, TH	15060	H	75	SCHD 80
LH LT	OC	3”	BUR	HDPE	BF	15021	H	65, except 75 for LH-30 and LH-24	SDR 11
LH LT	OC	4”	BUR	HDPE	BF	15021	H	65	SDR 17
LHCP LTCP	OC	2”	BUR	HDPE	BF	15021	P	8	SDR 11 for all except SDR 9 for 219A(E)201-2”-LTCP-043-HDPE
LHCP LTCP	OC	6” & 8”	BUR	HDPE	BF	15021	P	8	SDR 17
LT	LTB	All	EXP	PVC	SW, FL, TH	15060	H	75	SCHD 80
LT	TL	All	EXP	GSP	FL, TH	15060	H	65, except 75 for LT-37	SCHD 40

*Test pressures measured at Crest Pad Building. Isolate any appurtenances not rated for test pressure such as vacuum breakers and pressure gages.

Notes: 1. Test pressures shown are for a minimum allowable pressure. Maximum test pressures cannot exceed pressure rating of the pipe during the expansion phase of the pressure test.

SECTION 15100 – VALVES, OPERATORS, AND FILTER SCHED. A & B

Part 1 – General

Summary

This section is for furnishing and installing valves, filters, and associated components for leachate and raw water systems. Valves and accessories for raw water are identified as such. Other requirements apply to leachate and raw water systems.

References

The following is a list of standards, which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C550	Protective Epoxy Interior Coatings for Valves and Hydrants

ASTM INTERNATIONAL (ASTM)

ASTM A276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A351	Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts
ASTM B61	Standard Specification for Steam or Valve Bronze Castings
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B98	Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B127	Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
ASTM B139	Standard Specification for Phosphor Bronze Rod, Bar, and Shapes
ASTM B164	Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B194	Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D429	Test Methods for Rubber Property—Adhesion to Rigid Substrates
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Product data sheets for make and model.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Manufacturer's Certificate of Compliance for butterfly valves; full compliance with AWWA C504.

Submittals–Approval Not Required:

Information/Record (IR): Documentation of construction quality control testing as specified herein.

Part 2 – Products

General

Valve to include operator, actuator, hand wheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

Valve same size as adjoining pipe.

Valve ends to suit adjacent piping.

Size operator to operate valve for the full range of pressures and velocities.

Valve to open by turning counterclockwise.

Factory mount operator, actuator, and accessories.

Provide nametag for each valve. Nametag shall include valve tag number and be constructed of 16-Gauge Type 304 stainless steel, letters shall be 3/16-inch imposed, affix to valve with 16- or 18-gauge stainless steel wire.

Materials

Brass and bronze valve components and accessories that have surfaces in contact with liquids other than leachate to be alloys containing less than 16 percent zinc and 2 percent aluminum. Valves in service on leachate lines shall have no bronze, brass, or copper wetted parts.

Approved alloys are of the following ASTM designations:

B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

Stainless steel Alloy 18-8 may be substituted for bronze.

Factory Finishing

Exposed Valves:

Manufacturer's standard corrosion-resistant coating suitable for intended service.

Safety isolation valves and lockout valves with handles, hand wheels, or chain wheels “safety yellow.”

Epoxy Lining and Coating:

Use where specified for individual valves described herein.

In accordance with AWWA C550 unless otherwise specified.

Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.

Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

Valves

Ball Valves

Type V330 PVC Ball Valve 2 Inches and Smaller: Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

Manufacturers and Products:

Nibco; True-Bloc.

ASAHI America; Duo-Bloc.

Or approved equal.

Type V331 PVC Ball Valve 3 and 4 Inches: Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 polyvinyl chloride full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ANSI B16.1.

Manufacturers and Products:

Nibco.

ASAHI America.

Or approved equal.

PVC 3-Way Ball Valve 2 Inches and Larger: Valves shall be three-way type with port option necessary to either direct flow through leachate filter or bypass flow around leachate filter. Valve configuration shall allow filter replacement simultaneously with flow through filter bypass. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, double union design, solvent weld socket ends, or flanged ends drilled to ASME B 16.5, Class 150, elastomer seat, Viton or Teflon O-ring stem seals, full ported ball.

Manufacturers and Products:

Spears; True Union 2000.

Or approved equal.

Check and Flap Valve:

Type V609 PVC Self-Closing Check Valve 3 Inches and Smaller: ASTM D1784, Type I, Grade 1, PVC body, rated at 150 psi, Viton seats and seals, stainless steel spring.

Manufacturer and Product:

PLAST-O-MATIC; Series CKS.

PVC Swing Check Valve 4 Inch and Larger:

PVC body, flanged, rated at 150 psi at 70 degrees F minimum, EPDM elastomer seal.

Manufacturers and Product:

Hayward Model 5167.040

Self-Contained Automatic Valves:

Air Release Valve 1/2 Inch to 16 Inches:

1/2-inch through 3-inch NPT inlets and outlets, 4 inch and larger ANSI B16.1 flanged inlet with plain outlet and protective hoods.

Rated 150 psi working pressure, PVC body, EPDM seals.

Manufacturer and Product: IPEX; Series VAFV.

Vacuum Breaker Valve: 1/2-inch NPT inlet and outlet, PVC body, EPDM diaphragm, working pressure 100 psi.

Manufacturer and Product: PLAST-O-MATIC; Series VBM.

Gate Valves:

Type V100 Gate Valve 3 Inches and Smaller (Raw Water): All-bronze, screwed bonnet, single solid wedge gate, nonrising stem, rated 125-pound SWP, 200-pound WOG.

Manufacturers and Products:

Stockham; B103, threaded end.

Crane; 438, threaded end.

Type V130 Resilient Seated Gate Valve, 2 Inches to 12 Inches (Combined Sump and Truck Loading Station):

Iron body, resilient seat, bronze mounted, ANSI Class 125 flanged ends, nonrising stem in accordance with AWWA C509, design working water pressure 200 psig for 2 inches through 12 inches, full port, fusion-epoxy coated inside and outside per AWWA C550.

Provide 2-inch operating nut and operator extensions for the gate valves on the secondary containment piping that drains into the combined sump. Provide handwheel operators for the gate valves at the truck loading station.

Manufacturers and Products:

M&H Valve; AWWA C509.

U.S. Pipe; Metroseal.

Type V130 Resilient Seated Gate Valve, 4 Inches to 12 Inches (Raw Water):

Iron body, resilient seat, bronze mounted, ANSI Class 125 flanged ends, nonrising stem in accordance with AWWA C509, design working water pressure 200 psig for 2 inches through 12 inches, full port, fusion-epoxy coated inside and outside per AWWA C550.

Provide post indicating assembly with detachable crank handle for 12-inch gate valve at raw water tie-in.

Manufacturers and Products:

U.S. Pipe; Metroseal.

Clow Corp; Model F-61XX.

Butterfly Valves:

General:

Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:

Suitable for throttling operations and infrequent operation after periods of inactivity.

Elastomer seats, which are bonded or vulcanized to the body, shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.

Bubble-tight with rated pressure applied from either side.

No travel stops for disc on interior of body.

Self-adjusting V-type or O-ring shaft seals.

Isolate metal-to-metal thrust bearing surfaces from flowstream.

Valve actuators to meet the requirements of AWWA C504.

Type V530 Butterfly Valve 4 Inches to 24 Inches for Fire Protection Service (Raw Water):

UL Listed and FM Approved, flanged style, AWWA C504 Class 150B valve with cast iron body, aluminum-bronze disc, stainless steel stem, EPDM seat, geared operator with highly visible position indicator and detachable crank handle.

For buried service, provide post indicating assembly with detachable crank handle.

Manufacturers and Product: Pratt; PIVA.

Miscellaneous Valves:

Type V930 Fire Hydrant (Raw Water): Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 5 inches in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed, and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 8 inches above the ground grade. Hydrants shall have a 6-inch bell connection, two 2-1/2-inch hose connections, and one 4-1/2-inch pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25, and two finish coats of silicone alkyd paint conforming to SSPC Paint 21; color shall be safety yellow. Caps and chains shall be furnished.

Manufacturers and Products: Clow Medallion.

Type V931 Yard Hydrant (Raw Water): Non-freeze yard hydrant with 3/4-inch hose connection. Constructed of manufacturer's standard materials, rated for minimum pressure of 125 psi.

Manufacturers and Products: Wade 8610; or equal.

Accessories

Operating Wrenches (Raw Water): Two each T-handled galvanized operating wrenches for 2-inch square nut operator, 6 feet long.

Manufacturers and Products:

- Mueller; No. A-24610.
- Clow No.; F-2520.
- Two each T-handled galvanized forked operating keys for cross handled valves, 7 feet long.

Cast Iron Valve Box (Raw Water): Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.

Box: Cast iron with minimum depth of 9 inches.

Lid: Cast iron, minimum depth 3 inches, marked WATER.

Extensions: Cast iron.

Operators

Manual Operator:

General:

- Operator force not to exceed 40 pounds under any operating condition, including initial breakaway.
- Gear reduction operator when force exceeds 40 pounds.
- Operator self-locking type or equipped with self-locking device.
- Position indicator on quarter-turn valves.
- Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.

Exposed Operator:

- Galvanized and painted hand wheels.
- Lever operators allowed on quarter-turn valves 8 inches and smaller.
- Valve handles to take a padlock, and wheels a chain and padlock.

Buried Operator:

Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.

Buried valves shall have extension stems, bonnets, and valve boxes.

Leachate Filters

Stainless steel filter housings rated for 150 psi minimum at 120 degrees F and 160 gpm shall be installed as shown on the piping details. Each filter housing shall be installed with (12) 5 micron filter cartridges, each cartridge shall be 40 inches long. The filter housing shall have a mill finish and include installation of a vent valve with drain tubing, drain valves with drain tubing, and filter housing stand. The filter assembly shall have no more than a 10 psi pressure drop across the housing and clean filter cartridges when operating at 160 gpm of water flow. The filter inlet and outlets shall be ASME B16.5, Class 150 flanges. Furnish and install filter cartridges within filter housing, in addition provide a minimum of 72 additional filter cartridges for future filter changeouts.

The filter assembly shall include a wall mounted differential pressure indicator. The differential pressure indicator shall tie-in to the filter housing drain ports. The differential pressure indicator shall include a resettable drag pointer for indication of maximum differential pressure achieved, 4.5-inch dial, and a range of 0-15 psid.

Copper tubing shall be used for differential pressure indicator. Tubing shall be 1/4-inch seamless copper tubing conforming to ASTM B75. Wall thickness, diameter tolerances, and compression type brass fittings shall be in accordance with ASTM B251.

Manufacturers and Products:

Filter Assembly: GE Osmonics; NDV Series w/Hytrex Filter Cartridges (5 micron, 40-inch length).

Differential Pressure Indicator: Wika; 700.05.

Part 3 – Execution

Installation

Flange Ends:

Flanged valve boltholes shall straddle vertical centerline of pipe.

Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly; do not over tighten.

Screwed Ends:

Clean threads by wire brushing or swabbing.

Apply joint compound.

Valve Orientation:

Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.

Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.

Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

Construction Quality Control

Valves shall be tested prior to leak testing pipelines.

Construction General Contractor shall perform test that valves open and close smoothly.

Construction General Contractor shall count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.

END OF SECTION 15100

SECTION 15140 – PIPING SUPPORT SYSTEMS SCHED. B

Part 1 – General

Summary

This section is for furnishing and installing leachate piping support systems.

References

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM A525	Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

BUILDING OFFICIALS AND CODE ADMINISTRATORS (BOCA)

Basic Building Code

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

Uniform Building Code

MANUFACTURERS' STANDARDIZATION SOCIETY (MSS)

SP 58	Pipe Hangers and Supports-Materials, Design and Manufacture
SP 69	Pipe Hangers and Supports-Selection and Application
SP 89	Pipe Hangers and Supports-Fabrication and Installation

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Drawings of each piping support system to scale shown, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and shop drawing detail number.

Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

Definitions

Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.

Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

Design Requirements

General:

Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89.

Pipe Support Systems:

Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.

Seismic Load: Seismic performance category forces with seismic loads in accordance with local codes.

Safety Factor: Minimum of 5.

Maximum Support Spacing and Minimum Rod Size:

Steel or Ductile Iron Piping:

Maximum Support/ Pipe Size	Minimum Rod Size Hanger Spacing	Single Rod Hangers
1-inch and smaller	6 feet	1/4-inch
1-1/2-inch thru 2-1/2-inch	8 feet	1/4-inch
3-inch and 4-inch	10 feet	3/8-inch

Plastic and Fiberglass Piping:

Maximum Support Spacing: As recommended by manufacturer for flow temperature in pipe. Pipe insulation shall be included in the selection of maximum pipe support spacing.

Minimum Hanger Rod Sizing: Same as listed for steel pipe.

Framing Support System:

Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.

Column Members: Size in accordance with manufacturer's recommended method.

Support Loads: Calculate using weight of pipes filled with water.

Maximum Spans:

Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.

Other Pipelines and Special Situations: May require supplementary hangers and supports.

Electrical Conduit Support: Include in design of framing support system.

Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

Vertical Sway Bracing: 10-foot maximum centers, or as shown.

Part 2 – Products

General

When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

Materials:

Wetted and Submerged: Stainless steel.

Atmospheric Exposed: Galvanized or painted steel.

Hangers

Clevis Type:

- MSS SP 58, Type 1 or 6.
- Grinnell; Figure 104 or 260.
- B-Line; Figure B3198 or B3100.

Hinged Split-Ring Pipe Clamp:

- MSS SP 58, Type 6 or 12.
- Grinnell; Figure 104.
- B-Line; Figure B3198H.

Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

Attachments:

I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, 28, 29, or 30, which engage both sides of flange.

Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

Saddle Supports

Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

Nonadjustable Saddle:

- MSS SP 58, Type 37 with U-bolt.

Grinnell; Figure 259.

B-Line; Figure B3090.

Adjustable Saddle:

MSS SP 58, Type 38 without clamp.

Grinnell; Figure 264.

B-Line; Figure B3093.

Wall Brackets

Welded Steel Bracket:

MSS SP 58, Type 33 (heavy-duty).

Grinnell; Figure 199.

B-Line; Figure B3607.

One-Hole Clamp: Grinnell; Figure 126.

Channel Type:

Unistrut.

Kin-Line.

Pipe Clamps

Riser Clamp:

MSS SP 58, Type 8.

Grinnell; Figure 261.

B-Line; Figure B3373 or approved equal.

Channel Type Support Systems

Material:

Galvanized: Pre-galvanized in accordance with ASTM A525, Class G90, or hot-dip galvanized after fabrication.

Stainless Steel: Type 304 stainless steel.

Channel Size: 12-gauge, 1-5/8-inch wide series minimum.

Members and Connections: Design for all loads with safety factor of 5.

Manufacturers and Products:

Kin-Line; Series CI3812.

Unistrut; Series P3200.

B-Line; B2000 Series, or approved equal.

Anchoring Systems

Material:

Wetted and Submerged: Stainless steel.

Atmospheric Exposed: Galvanized.

Size: Sized by equipment manufacturer, 1/2-inch minimum diameter.

Shop/Factory Finishing

Prepare, prime, and finish coat in accordance with:

Surface preparation with abrasive blast or centrifugal wheel blast (SP10).

Paint with:

One coat, 2.5 minimum dry film thickness (MDFT) of Epolon rust inhibitor primer.

One coat, 2.5 MDFT Epolon Multi-Mill Epoxy.

One coat, 1.5 MDFT Acrolon II, No. 2200 Series.

Part 3 – Execution

Installation

General:

Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.

Support piping connections to equipment by pipe support and not by the equipment.

Support large or heavy valves, fittings, and appurtenances independently of connected piping.

Support no pipe from the pipe above it.

Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

Install lateral supports for seismic loads at all changes in direction.

Repair mounting surfaces to original condition after attachments are made.

Standard Pipe Supports:

Horizontal Suspended Piping:

Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.

Grouped Pipes:

Trapeze hanger systems.

Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

Horizontal Piping Supported From Walls:

Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

Stacked Piping:

Wall-mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.

Piping clamps, which resist axial movement of pipe through support not acceptable.

Wall-mounted piping clips not acceptable for insulated piping.

Horizontal Piping Supported From Floors:

Stanchion Type:

Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

Floor Mounted Channel Supports:

Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

Attach channel framing to floors with anchor bolts.

Attach pipe to channel with clips or pipe clamps.

Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

Standard Attachments:

To Steel Beams: I-beam clamp or welded attachments.

To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

Field Finishing

Paint atmospheric exposed surfaces of black and hot-dip galvanized steel components as specified in Article SHOP/FACTORY FINISHING.

END OF SECTION 15140

SECTION 15500 – HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS SCHED. B

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

AIR MOVING AND CONDITIONING ASSOCIATION (AMCA)

AMCA 99	Air Movement and Control Association Standards Handbook
AMCA 210	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	Reverberant Room Method for Sound Testing of Fans
AMCA 2401	Impeller Diameters and Outlet Areas for Centrifugal Fans and Metric Equivalents

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND

AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52	Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 90A	Energy Conservation in New Building Design

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1-	Motors and Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS'

NATIONAL ASSOCIATION (SMACNA)

Guidelines for Seismic Restraints of Mechanical Systems

HVAC Testing, Adjusting, and Balancing Manual

UNDERWRITERS LABORATORIES INC. (UL)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics for the following products:

Air conditioning units.

Unit heaters.

Motorized dampers.

Complete performance data that indicate full compliance with the Specifications.

Recommended procedures for protection and handling of equipment and materials prior to installation.

Manufacturer's certification of factory testing to establish conformance with specified requirements for the unit heater and air conditioning unit.

For motors specified to be energy efficient type, certified copy of test report for identical motor tested, in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing full load efficiency.

Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

Submittals–Approval Not Required

Information/Record (IR):

List of recommended spare parts for equipment and materials specified.

Manufacturer's warranty.

Operations and maintenance manuals including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Extra Materials

Furnish, tag, and box for shipment and storage the following spare parts:

Filters: Four complete sets per unit.

Special Guarantee

Manufacturer shall provide standard warranty.

Part 2 – Products

General:

Heating Equipment: Minimum operating efficiencies as specified in Chapter 6 of ASHRAE Standard 90A, and the State of Washington Energy Code.

Wall-Mounted Air-Cooled Packaged Air Conditioning Units (For Equipment Identification Numbers See Supplement)

General:

Packaged through-the-wall air conditioning unit.

Cooling section.

Heating section.

Controls.

Fans.

Filters.

All contained in a standard weatherproof enclosure.

UL listed.

Enclosure:

Zinc-coated steel finished with manufacturer's standard baked enamel paint.

Adjustable discharge grille.

Return grille.

Permanent filter.

Internal sound attenuation.

Controls with adjustable thermostat.

Fan speed switch with HIGH/LOW manual selections.

Heating Section:

Low-density electric heating elements.

Built-in overheat protection.

Cooling Section:

Hermetic compressor.

Air-cooled condenser coil.

Evaporator coil.

Drain pan with drain line connections.

Direct-drive evaporator.

Condenser fans.

Fan motors with integral overload protection.

Operating and safety controls.

Operating charges of refrigerant and oil.

Capacity (219A-LH-AC-001 and 219E-LH-AC-001): 600 cfm at fan medium speed, at 0.3 inch of water column static pressure, minimum outside air 100 cfm, cooling capacity 25,110 Btuh total, 17,530 Btuh sensible, 85/72 degrees F DB/WB entering air temperature, and 100 degrees F ambient, 208-volt, single-phase power supply, MCA17, breaker size 20 amps.

Capacity (219A1-LH-AC-002 and 219E1-LH-AC-002): 360 cfm at 0.3 inch of water column static pressure, minimum outside air 100 cfm, cooling capacity 11,840 Btuh total, 8,130 Btuh sensible, 85/72 degrees F DB/FB entering air temperature, and 100 degrees F ambient, 208-volt, single-phase power supply, MCA 8 amps, breaker 15 amps.

Manufacturers and Products:

Bard:

Model (219A-LH-AC-001 and 219E-LH-AC-001): WA241-A-00-EXXXXA.

Model (219A1-LH-AC-002 and 219E1-LH-AC-002): WA121-A-00-EXXXXJ.

Or approved equal.

Electric Unit Heater (For Equipment Identification Numbers See Supplement)

General:

Heater shall be installed and wired in accordance with the manufacturer's recommendations.
Unit heater shall be UL listed.

Casing:

Fabricated of die-formed, heavy-gauge steel and finished in high gloss, baked enamel.
Supply air shall be drawn through a stamped louver periphery evenly across the heating element.
Discharge air shall be through an outward drawn Venturi.
Cabinet shall have adjustable discharge louvers.
Cabinet shall be furnished with an access door.
Wiring diagram shall be permanently attached to the inside at the access door.

Elements:

Elements shall be high mass, all steel tubular finned type, copper brazed.
Elements shall be centrally located and installed in fixed element banks.

Motor:

Motor shall be totally enclosed, all angle industrial rated.
Bearings shall be sealed and permanently lubricated.

Fan:

Fan blades shall be of the axial flow type.
Fan speed shall not exceed 1,600 rpm.

Wiring:

Unit heater shall be factory prewired.
Unit heater shall have balanced phases.
Unit heater shall be equipped with automatic reset thermal overload.

Controls: Wall-mounted thermostat.

Manufacturers and Products:

Capacity: 3.3 kW, 460 volts, three-phase, horizontal discharge.

Trane; UHEC-033DACA.

Relief Louver (For Equipment Identification Numbers See Supplement)

Extruded aluminum frame.

Double drainable blades.

Bird screen.

Size: Louver size as shown on Drawings.

Manufacturer And Product: Ruskin; Model ELF 375DD.

Damper Actuator (For Equipment Identification Numbers See Supplement)

Line voltage actuator.

Spring return.

UL listed.

NEMA 2 housing.

60-inch-pound torque.

Sequence of Operation: Actuator shall be interlocked with an economizer. Actuator shall be energized when economizer is on, and shall be closed when economizer is off.

Manufacturer and Product: Belimo; NF120US, 120 volts, single-phase, less than 60 seconds return time.

Sequence Of Control

Air Conditioning Units:

Air conditioning unit shall be started by the signal from wall-mounted thermostat if the room temperature rises above 85 degrees F.

Thermostat set point is 80 degrees F.

If the room temperature drops below 70 degrees F, the modulating type return, outside and exhaust air dampers will be adjusted to maintain room temperature.

When outside air temperature is between 50 degrees F and 65 degrees F, air conditioning unit will provide a free cooling.

Unit Heaters: Unit heater will be operating in the ON-OFF sequence to maintain 50 degrees F temperature.

Part 3 – Execution

Installation

Install equipment and systems in accordance with manufacturers' instructions.

Packaged Wall-Mounted Air Conditioning Units:

Mount unit in accordance with manufacturer's instructions.

Provide access for maintenance.

Seal watertight to wall.

Electric Unit Heater: Install in accordance with recommendations of NFPA 90A.

Supplements

The supplement listed below, following "END OF SECTION," is a part of this Specification.

Equipment Identification Numbers.

END OF SECTION 15500

Equipment Identification Numbers

Location	Equipment Name	Equipment Number
Cell No. 1 Crest Pad Building	Air Conditioning Unit Unit Heater Relief Louver with Motorized Damper	219A-LH-AC-001 219A-LH-UH-001 219A-LH-MD-001
Cell No. 1 Leachate Transfer	Air Conditioning Unit Building Unit Heater Relief Louver with Motorized Damper	219A1-LH-AC-002 219A1-LH-UH-002 219A1-LH-MD-002
Cell No. 2 Crest Pad Building	Air Conditioning Unit Unit Heater Relief Louver with Motorized Damper	219E-LH-AC-001 219E-LH-UH-001 219E-LH-MD-001
Cell No. 2 Leachate Transfer	Air Conditioning Unit Building Unit Heater Relief Louver with Motorized Damper	219E1-LH-AC-002 219E1-LH-UH-002 219E1-LH-MD-002

SECTION 15992 – PIPING LEAKAGE TESTING SCHED. B

Part 1 – General

Summary

This section is for leak testing (construction quality control) leachate piping and associated components.

Submittals–Approval Required:

See Section 01300, SUBMITTALS, for submittal procedures.

Testing Plan:

- Submit prior to testing and include at least the information that follows.
- Testing dates.
- Piping systems and section(s) to be tested.
- Test type.
- Method of isolation.
- Sample of test report form.

Certifications of Calibration: Testing equipment.

Submittals–Approval Not Required

Information/Record (IR): Certified Test Report.

Provide Manufacturer's calibration recommendations and current calibrations of pressure gauge(s).

Part 2 – Products (Not Used)

Part 3 – Execution

Preparation

Notify Construction Manager in writing 5 days in advance of testing. Perform testing in presence of Construction Manager.

Pressure Piping:

- Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
- Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
- Items that do not require testing include: Piping between wetwells and wetwell isolation valves, tank overflows to atmospheric vented drains, tank atmospheric vents, and slotted piping.
- Test section may be filled with water and allowed to stand under low pressure prior to testing.

Other Piping:

Perform testing of other pipe service types using the same methods outlined for pressure piping.

Hydrostatic Test

General: Hydrostatic testing shall be performed on all single-wall pipe, inner carrier pipes, and all PVC piping.

Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

Test Pressure:

Per Section 15060, Piping–General

Exposed Piping:

Perform testing on installed piping prior to application of insulation.

Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.

Maximum Filling Velocity: 0.25 feet per second, applied over full area of pipe.

Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

HDPE Piping

Test Procedure: The test procedure consists of an initial expansion phase and then the test phase. Prior to the test procedure the test medium and pipe test section shall be allowed time to equalize in temperature. Testing shall not be allowed if temperatures of the test medium or pipe test section exceed 100 degrees F.

Maintain the test pressure for a period of 3 hours during the initial expansion phase by adding water as needed.

At the beginning of the test phase after the initial expansion phase, reduce pressure by 10 psi. Maintain this test pressure for a period of 1 hour.

Under no circumstances shall the testing be allowed to exceed 8 hours.

Acceptance Criteria:

The test phase is passed and the pressure test is acceptable if the pressure remains steady (within 5 percent of the test phase beginning pressure) for 1 hour and there are no indications, visible or otherwise, of leakage.

If acceptance criteria is not met, any leakage points shall be fixed and any other changes made to the piping system as necessary. Retest and repeat until acceptance criteria is met.

Empty pipe of water prior to final cleaning.

Buried Piping: Test piping using the same procedure as outlined for exposed piping as described above.

PVC and Non-HDPE Piping:

Perform testing on installed piping prior to application of insulation.

Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.

Maximum Filling Velocity:

0.25 foot per second, applied over full area of pipe.

Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage. No fluid shall be added to the system, and system shall not drop below 95 percent of the test pressure during the test period.

Examine exposed joints and connections for leakage.

No loss of fluid allowed. Find any leakage points, fix, and retest as specified.

Empty pipe of water prior to final cleaning or disinfection.

Pneumatic Test

General: Pneumatic testing shall be performed for outer pipe of double-wall HDPE piping and atmospheric drains.

Double-Wall Pipe: Inner carrier pipe shall be full of water when outer containment pipe is tested to prevent damage to carrier pipe and riser pipes.

Equipment:

Gauges shall be calibrated within manufacturer's recommended frequency and calibration shall be current.

Install gauges, air piping manifolds, and valves at ground surface.

Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 10 psi or less.

Restrain plugs used to close lines to prevent blowoff.

Procedure:

Maintain test pressure for 10 to 60 minutes but not for more than 60 minutes.

Slowly introduce air into pipe section until internal air pressure reaches required test pressure. (A maximum 5% gauge loss is acceptable.)

Allow 2 minutes minimum for air temperature to stabilize.

Examine exposed joints and connections for leakage using liquid bubble tests or other method to determine source of leakage approved by the construction manager.

No loss in pressure allowed. Find any leakage points, fix, and retest as specified.

Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

END OF SECTION 15992

DIVISION 16 – ELECTRICAL

SECTION 16005 – ELECTRICAL

Part 1 – General

UL And NRTL Compliance

Materials manufactured within the scope of UL or another nationally recognized testing laboratory (NRTL) shall conform to UL or NRTL standards and have an applied UL or NRTL listing mark. References to UL throughout this section imply conformity with UL or NRTL standards and guidelines.

Electrical system process control panels shall be manufactured, assembled, tested, approved, and clearly labeled in accordance with UL 508A, prior to delivery to construction site.

Approval By Authority Having Jurisdiction (AHJ)

Provide all work in accordance with NFPA 70, National Electrical Code, ANSI C2 National Electrical Safety Code (NESC), and where required by Hanford CH2M HILL authority having jurisdiction (AHJ), as defined under Division 1, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to AHJ, in order to provide a basis for approval under NEC.

All material and equipment shall be tested after installation by a qualified testing firm (as specified in Section 16080, ELECTRICAL TESTING), or other organization acceptable to AHJ, in order to provide a basis for approval under NEC. Construction General Contractor is responsible for providing qualified testing firm and shall coordinate with the Construction Manager for NEC inspection services.

All material and equipment shall be provided with a visibly attached label by a nationally recognized testing laboratory or other organization acceptable to AHJ, prior to delivery to construction site.

All motor control panels shall be provided in accordance with UL 508 and with a visibly attached label by a nationally recognized testing laboratory or other organization acceptable to AHJ, prior to delivery to construction site.

All equipment shall be installed per manufacturer's instructions, with NFPA 70, NESC, and with other applicable requirements.

All electrical work including conduit, wiring, and terminal and splice connections shall be accomplished by a state-registered and approved electrical journeyman or a state-registered and approved electrical apprentice under supervision of state-registered and approved electrical journeyman.

Electrical Description Of Work

Schedule A Work:

Provide and install primary aerial cables, power poles, fuse-cutouts, supports, primary riser conductors, and ancillary equipment as needed to extend existing primary power circuit C8–L6 from 4th street to new IDF pad mount service transformer as shown on Drawings and in accordance with Section 16312, OVERHEAD ELECTRICAL DISTRIBUTION.

Provide and install IDF pad mount service transformer as shown on Drawings and in accordance with Section 16270, Oil-Filled Pad Mounted Transformer.

Provide site preparation, pad mount slab and concrete work, and grounding as necessary to facilitate utility vault and pad mount service transformer installation.

For primary (15kV) conductors, which route from riser pole fuse cut-outs to pad mount service transformer, reference CONDUCTOR OVER 600 VOLTS this Section.

Fluor Hanford Electrical Utilities will make final aerial conductor connections to existing primary circuit C8–L6, and primary connections to pad mount service transformer.

Coordinate installation of all primary service equipment, testing, and secondary metering with Construction Manager, who will contact Fluor Hanford Electrical Utilities (FH EU).

Schedule B Work:

Provide and install power conduits and cables to electrical service gear for each crest pad and leachate transfer building. Power conduits and cables shall route from crest pad building electrical service gear to power handhole(s) and service transformer as shown on Drawings.

FH EU will make final secondary conductor connections within low voltage compartment of pad mount service transformer after cables are routed under this schedule of work.

Coordinate with FH EU installation of secondary cables and energizing of secondary service equipment.

Provide and install communication conduits and cables for each crest pad and leachate transfer building communication service. Communication conduits and cables shall route below grade from crest pad building to communication handhole(s) as shown on Drawings.

Provide and install electrical service gear for each crest pad and leachate transfer building including: motor control center (MCC), MCC integrally mounted lighting panel and transformer, and grounding electrode system.

Motor control center shall provide 480V, three-phase, three-wire power to pump motors, power outlets, building heaters, air monitoring transformer and panel assemblies, and motor starters.

Lighting panel and transformer shall provide 208/120V, three-phase, four-wire power for instruments, lighting, receptacles, small motor loads, and miscellaneous panels.

Lighting panel and transformer(s) shall provide 120/240V, single-phase, three-wire power for air monitoring equipment and ancillary lighting and receptacles.

Provide and install grounding electrode system at each crest pad and leachate transfer building. Bond service gear, lighting transformer, power and communication panels, and metal structures (i.e., leachate storage tank, buildings) to grounding electrode system.

Provide and install power conduits and cables to the following three-phase equipment:

Building unit heaters.

Leachate collection and removal and leak detection system pumps.

Combined sump pumps.

Leachate transfer pumps.

Portable generator power outlets.

Provide and install power conduits and cables to the following single-phase equipment:

Building interior and exterior lighting.

Building receptacles.

Building control panels.

Building air conditioning units.

Heat tracing.

Air monitoring equipment.

Provide and install control and signal conduits and cables to the following instrumentation:

Process local control panels.

Building temperature transmitters.

Building sump level floats and panels.

Building ventilation thermostats.

Leachate collection and removal and leak detection system pump flow meters and submersible pressure transmitters.

Storage tank level transmitters and switches.

Leachate collection carrier pipe leak detection level switches, mounted in combined sumps' interstitial spaces.

Combined sump level floats.

Leachate transfer flow meters and transmitters.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Primary and secondary service entrance and metering equipment.

Boxes and device plates.

Junction and pullboxes.

Precast utility vaults, manholes and handholes.

Wiring devices.

Panelboards and mini-power centers.

Circuit breakers and switches.

Motor-rated switches.

Control devices, terminal blocks, and relays.

Contactors.

Transformers.

Support and framing channels.

Nameplates and nameplate schedule.

TVSS equipment.

Volt and current meters.

Conduit, fittings, and accessories.

Wireways.

Conductors, cable, and accessories.

Motors:

Nameplate data, detailed information on any special features.

Grounding materials.

Motor Controls: Arrangement drawings, ratings, schematic and wiring diagrams, bill-of-materials, nameplate schedule, manufacturer information on components.

Local Control Panels:

Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.

Luminaires.

Factory test reports.

Submittals–Approval Not Required

Information/Record (IR):

Field test reports.

Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.

Operation and Maintenance Data:

Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance, in accordance with Division 1, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

Environmental Conditions

Provide equipment and conduit systems approved for installing in the following environmental conditions:

Climatic and Geographic Site Conditions:

Site Elevation: 1,000 feet.

Relative Humidity: 90 percent maximum at 30 degrees F dry bulb, 15 percent minimum at 60 degrees F dry bulb.

Uniform Building Code: Seismic Zone 2B.

Temperature: 105 degrees F max. 0 degrees F min.

Enclosures and Environmental Conditions:

Provide and install NEMA 250 Type 4X, Type 304 stainless steel (corrosion resistant, wash down protection) enclosures in process mechanical and wash down indoor locations unless otherwise noted within this section.

Provide and install NEMA 250 Type 3 (dust, rain and ice protection) enclosures in outdoor locations unless otherwise noted in this section.

Provide NEMA 250 Type 12 (dust protection) enclosures for indoor dry protected locations unless otherwise noted in this section.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches.

Part 2 – Products

General

Products shall comply with all applicable provisions of NFPA 70.

Like Items of Equipment: End products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.

Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature ranges identified under ENVIRONMENTAL CONDITIONS in this section.

Hazardous Areas: Products shall be acceptable to the regulatory authority having jurisdiction for the interior of the combined sumps. Class 1, Division 2, Groups C and D.

Equipment Finish: Manufacturer's standard finish color, except where specific color is indicated.

Service Entrance

Coordinate all service entrance work with Construction Manager, who will in turn coordinate with Fluor Hanford Electrical Utilities, contact person: Cris Carlson, P.E., 509-521-2823.

Utility Metering

Watt-hour Meter: Socket type, for three-phase, 4-wire wye service, self-contained, with relay option board having output for watt KYZ pulses, 480 volt, class 200, form 16S, Elster alpha plus, type A1D+.

Meter Socket: Provide with manual circuit closing blocks, 7 terminal, 200 amp, 600 volt, Milbank type U3517-XL.

Meter Base Hub: Provide for standard RL opening, 2-inch, Milbank type A7517.

Lighting And Power Distribution Panelboard

NEMA PB 1, NFPA 70, and UL 67.

Panelboards and Circuit Breakers: Suitable for use with 75 degrees C copper wire at full NFPA 70, 75 degrees C ampacity.

Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

Rating: Applicable to a system with available short-circuit current of 10,000 amperes rms symmetrical at 208/120 volts and 120/240 volts.

Ground Fault Circuit Interrupter (GFCI): UL Class A GFCI, 5-mA trip, 10,000-amp interrupting capacity circuit breakers.

Ground Fault Equipment Protection (GFEP): 30-mA trip, 10,000-amp interrupting capacity circuit breaker, UL listed for equipment ground fault protection.

Interior Panelboard: NEMA 250, Type 12 unless otherwise noted.

Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame.

Wiring Gutter: Minimum 4 inches square; both sides, top and bottom.

Front: Fastened with adjustable clamps.

Interior:

Factory assembled; complete with circuit breakers.

Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.

Spaces: Cover openings with easily removable metal cover.

Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

Bus Bar:

Material:

Copper and/or tin-plated copper full sized throughout length.

Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

Neutral bus with at least two (neutral and ground) terminal screws for each circuit.

Note: Do not install multiwire branch circuits that share common neutral. Install neutral for each 120-volt branch circuit.

Lugs and Connection Points:

Suitable for copper conductors.

Solderless main lugs for main, neutral, and ground bus bars.

Bolt together and rigidly support bus bars and connection straps on molded insulators.

Circuit Breakers:

NEMA AB 1 and UL 489.

Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.

Noninterchangeable, in accordance with NFPA 70.

Locking: Provisions for handle padlocking, unless otherwise shown.

Type:

Bolt-on circuit breakers in all panelboards.

Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.

Do not substitute single-pole circuit breakers with handle ties for multipole breakers.

Do not use tandem or dual circuit breakers in normal single-pole spaces.

Ground Fault Circuit Interrupter (GFCI):

Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-mA ground fault (UL 943, Class A sensitivity).

Sensor with same rating as circuit breaker and a push-to-test button.

Manufacturers:

Square D

Cutler-Hammer

General Electric

Allen-Bradley

Mini-Power Center (MPC)

General: Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 3 enclosure.

Transformer:

Type: Dry, self-cooled, encapsulated.

Insulation: Manufacturer's standard, with UL 1561 temperature rise.

Full Capacity: 2-1/2 percent voltage taps, two above and two below normal voltage.

Primary Voltage: 480, three-phase; 480 single-phase as shown.

Secondary Voltage: 208/120 volts, three-phase, four-wire; 120/240 volts, single-phase, three-wire as shown.

Size: 7.5 kVA and 15 kVA as shown.

Panelboard: UL 489, fully rated.

Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.

Number and Breaker Ampere Ratings: Refer to Panelboard Schedule.

Manufacturers:

- Square D Co.
- Cutler-Hammer.
- General Electric Co.

Lighting And Power Distribution Stepdown Transformer (0-600 Volts)

Type: Self-cooled, two-winding.

UL 1561 and NEMA ST 20.

Insulation Class/Temperature Rise: 115 Degrees F.

Core and Coil:

30 kVA or Less: Encapsulated.

Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

Sound Level: Not to exceed NEMA ST 20 levels.

Vibration isolators to minimize and isolate sound transmission.

Manufacturers:

- Square D
- Cutler-Hammer/Westinghouse
- General Electric.

Local Control Panels

Enclosure:

- Reference ENVIRONMENTAL CONDITIONS in this section.

Minimum Metal Thickness: 14 gauge.

Doors: Rubber gasketed with continuous hinge.

Incandescent Light: Hand switch controlled, 100-watt.

Receptacle: Breaker protected 120-volt, 15-amp duplex.

Finish: Internal and external surfaces (NEMA 250, Type 12 only):

- Sand panel; remove mill scale, rust, grease, and oil.
- Fill imperfections and sand smooth.

Paint with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.

Sand surfaces lightly between coats.

Final Dry Film Thickness: Minimum 3 mils.

Size panels to adequately dissipate heat generated by equipment mounted in or on panel.

Manufacturers:

Hoffman.

H. F. Cox.

Wiring:

Power and Control Wiring: 600-volt class, insulated, stranded copper.

Size: Minimum No. 14 AWG enclosed in either sheet metal raceway or plastic wiring duct.

Signal Circuit Wiring: Twisted shielded pairs minimum No. 16 AWG, separated at least 6 inches from power wiring.

Identification: Permanent heat impregnated polyvinyl chloride (PVC) alpha-numeric labels.

Safety Switches

UL 98 listed for use and location of installation.

Type: Visible blade, fusible.

Class: Heavy-duty.

Enclosures: Reference ENVIRONMENTAL CONDITIONS in this section.

Circuit Breaker, Individual, 0 To 600 Volts:

UL 489 listed for use at location of installation.

Minimum Interrupt Rating: As shown.

Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of operating handle.

Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

Locking: Provisions for padlocking handle.

Enclosure: Reference ENVIRONMENTAL CONDITIONS in this section.

Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

Manufacturers:

Square D Co.

Cutler-Hammer.

General Electric Co.
Allen-Bradley.

Fused Switch, Individual, 0 To 600 Volts:

UL 98 listed for use and location of installation.
NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current as shown.
Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

Enclosure: Reference ENVIRONMENTAL CONDITIONS in this section.

Interlock: Enclosure and switch to prevent opening cover with switch in ON position.

Manufacturers:

Square D Co.
Cutler-Hammer.
General Electric Co.

Fuse, 0 To 600 Volts

Current-limiting, with 42,000 max ampere rms interrupting rating.
Provide to fit mountings specified with switches and features to reject Class H fuses.

Motor and Transformer Circuits, 0 to 600 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann: Type LPS-RK.
Littelfuse, Inc.: Type LLS-RK.

Motor and Transformer Circuits, 0 to 250 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann; Type LPN-RK.
Littelfuse, Inc.; Type LLN-RK.

Feeder and Service Circuits, 0 to 600 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann; Type LPS-RK.

Littelfuse, Inc.; Type LLS-RK.

Magnetic Control Relays

NEMA ICS 2, Class A600 (600 volts, 10 amperes continuous, 7,200VA make, 720VA break), machine tool type with field convertible contacts.

Smaller Magnetic Control Relays: Reference Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS).

Time Delay Relay

Industrial Relay Rated: 150 volts, 5 amps continuous, (3600 VA make, 360 VA break).

Solid-state electronic, field convertible ON/OFF delay.

Two Form-C contacts (minimum).

Repeat accuracy plus or minus 2 percent.

Timer Adjustment: Multiple adjustable ranges, including 1 to 60 seconds, unless otherwise shown.

Manufacturers:

- Omron.
- Cutler-Hammer.
- General Electric Co.
- Allen-Bradley.

Elapsed Time Meters

Type: Synchronous motor driven, 0 to 99,999.9 hours range, nonreset, suitable for semiflush, panel mounting.

Manufacturers:

- General Electric Co.
- Veeder-Root.

Phase Monitor Relay

Voltage and phase monitor relay shall drop out on loss of phase, or phase reversal.

Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.

Adjustable trip and time delay settings.

Transient Protection: 1,000V ac.

Mounting: Multipin plug-in socket base.

Accessories: Provide properly sized and rated line isolating switches and fuses for each phase monitored.

Manufacturer:

Square D Co.
Cutler-Hammer.
General Electric Co.
Allen-Bradley.

Transient Voltage Surge Suppressor (TVSS) Equipment

General: Units shall be suitable for the service voltage and configuration (phases and wires) shown.

Protection Modes:

Normal, differential, and common.
Bipolar or bi-directional.

Ratings:

Short-circuit current rating shall equal or exceed that of protected distribution equipment. Surge Voltage Rating (SVR) shall not exceed those specified under UL 1449 for the associated nominal system voltage. Maximum Allowable Continuous Operating Voltage (MCOV) shall be at least 115 percent of the nominal system voltage.

Unit shall be UL-listed.

Provide status indicators for unit ON-LINE and unit operation NORMAL.

Provide common alarm contact output.

Provide fusible disconnect switch (integral with TVSS unit, where available) where not shown connected via branch circuit device of protected distribution equipment.

Minimum Enclosure Rating: NEMA 250, Type 12.

Type 2 TVSS:

Requirements: Designed for critical loads at service equipment (Category C3/B3) or distribution panelboard (Category C2/B3) locations. Unit shall utilize voltage-matched Silicon Avalanche Suppressor Diode (SASD) technology. Unit shall utilize modular, plug-in suppressor design.

Manufacturer and Product: Transtector; Model Apex III (nonservice entrance distribution panelboard) or Apex IV (service equipment).

Volt And Current Meters

Voltmeter, Panel Type:

NEMA 250 Type 12.

Nominal 3-1/2 inch model.

90 degree scale; accuracy of plus or minus 2 percent.

Manufacturer: Same as Manufacturer of Motor Control Center.

Voltmeter Switch:

NEMA 250 Type 12.

Rotary cam type with pistol grip handle engraved escutcheon.

Four-position, phase-to-phase, and OFF.]

Manufacturer: Same as Manufacturer of Motor Control Center.

Ammeter, Panel Type:

NEMA 250 Type 12.

Nominal 3-1/2-inch model.

90 degree scale; accuracy of plus or minus 2 percent.

Manufacturer: Same as Manufacturer of Motor Control Center.

Ammeter Switch:

NEMA 250 Type 12.

Rotary cam type with pistol grip handle engraved escutcheon.

Four-position, three-phase currents, and OFF.

Manufacturer: Same as Manufacturer of Motor Control Center.

Conduit And Fittings

Rigid Galvanized Steel Conduit (RGS)

ANSI C80.1.

Fittings: Threaded type.

Galvanize by hot-dipping, electroplating, sherardizing, or metalizing process, including fittings.

Polyvinyl Chloride Conduit (PVC):

Rigid, Schedule 40, NEMA TC 2.

UL 651 listed for concrete encased, direct burial, concealed and direct sunlight exposed use.

UL 651 listed and marked for use with conductors having 90 degrees C insulation.

Fittings: NEMA TC 3, for intended use.

Flexible Metal Liquid-Tight Conduit:

UL 1 listed for liquid-tight service.

Galvanized steel, flexible conduit covered with extruded PVC jacket.

Termination: Nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

Interior Conduit Sealing:

Spare conduits should be capped in panels and handholes.

Conduits inside handholes will be sealed using spray insulating foam or other material, which is non-deleterious to conductors and cables.

Conduits inside panels will be sealed using insulating foam or other material, which is non-deleterious to conductors and cables.

Conduit Sealing Fitting:

Restrict the passage of gasses, vapors, or flames from one portion of the electrical installation to another at atmospheric pressure and normal ambient temperatures.

In conduit systems when leaving Class 1, Division 2 hazardous locations.

Manufacturers and Products:

Appleton; Type EYF, EYM, or ESU.

Crouse-Hinds; Type EYS or EZS.

Fitting Sealing Compound: Form a seal around each electrical conductor and between them and inside of the sealing fitting to restrict the passage of gases, vapors, or flames through the sealing fitting.

Manufacturers and Products:

Appleton; Kwiko.

Crouse-Hinds; Chico.

Identification Devices: Conduit tags.

Material: Permanent, nylon.

Shape: Round.

Conduit Designation: Pressure stamped, embossed or engraved.

Support and Framing Channels

Carbon Steel Framing Channel:

Material: Rolled, mild strip steel, 12-gauge, ASTM A570, Grade 33.

Finish: Hot-dip galvanized after fabrication.

Paint-Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

Manufacturers:

B-Line Systems, Inc.

Unistrut Corp.

Aickinstrut.

Precast Utility Vaults, Manholes and Handholes

Concrete Strength: Minimum 3,000 psi compressive, in 28 days.

Loading: AASHTO H-20, in accordance with ASTM C857.

Drainage: Slope floors toward drain points, leaving no pockets or other nondraining areas.

Raceway Entrances:

Provide on all four sides along with pulling eyes.

For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.

At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

Handhole Frames and Covers:

Material: Steel, hot-dipped galvanized.

Cover Type: Solid, torsion spring of checkered diamond design.

Cover Loading: AASHTO H-20.

Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:

Above 600 Volts: ELECTRIC HV.

600 Volts and Below: ELECTRIC LV.

Instrumentation, Communication: Signal.

Hardware: Steel, hot-dip galvanized.

Furnish knockout for ground rod in each handhole.

Manufacturers:

Utility Vault Co.

Penn-Cast Products, Inc.

Concrete Conduit Co.

Associated Concrete Products, Inc.

Pipe, Inc.

Conductors 600 Volts And Below

Material: Annealed copper.

Insulation:

No. 8 AWG and Smaller: Type THW, THWN or XHHW conductors may be utilized at Construction General Contractor's option, subject to code requirements.

No. 6 AWG and Larger: Type XHHW.

Direct Buried: Type XLPE-USE.

Flexible Cord and Cable: Type SO, 600 volts.

Signal: Type 3, No. 16 AWG twisted, shielded pair instrumentation cable, 45-mil PVC outer jacket, 600-volt rating.

Type:

Control Conductor No. 14 AWG and Smaller: Stranded.

Power Conductors No. 10 AWG and Smaller: Solid or stranded.

Power Conductors No. 8 AWG and Larger: Stranded.

Type 3: No. 16 AWG stranded (copper seven-stranded)

Conductors Above 600 Volts (Schedule A Work Only)

Ethylene-Propylene Rubber (EPR) Insulated Cable:

Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.

Type: 15kV, tape shielded UL 1072, Type MV-90.

Conductors: Copper concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B263.

Conductor Screen: Extruded, semi-conducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 6.

Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR), containing no polyethylene in accordance with NEMA WC 71, and AEIC CS 6.

Insulation Thickness: 220-mil, 15 kV, nominal.

Insulation Screen: Thermosetting, semi-conducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74, and AEIC CS 6.

Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with [17-1/2] percent minimum overlap.

Jacket: Extruded polyvinyl chloride (PVC) compound applied over the metallic shield in accordance with NEMA WC 71.

Operating Temperature: 90 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.

Manufacturers:

Okonite Co.

Pirelli Wire and Cable.

BICC.

Southwire Co.

<u>Accessories For Conductors Above 600 Volts (Schedule A Work Only)</u>

Termination Kits:

Capable of terminating 15 kV, single-conductor, polymeric-insulated tape shielded cables plus a shield ground clamp.

Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.

Capable of accommodating any form of cable shielding or construction without the need for special adapters or accessories.

Manufacturers:

Raychem.

3M Co.

Elbow Connector Systems: Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95kV BIL, 200A, 10,000A rms load-break elbows as shown having all copper current-carrying parts in accordance with ANSI 386.

Protective Caps: Class 15 kV, 95 kV BIL, 200 amperes, with molded EPDM insulated body.

Insulated Standoff Bushings: Class 15kV, 95kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.

Bushing Inserts: 15kV, 95kV BIL, 200A, load-break with EPDM rubber body and all-copper, current-carrying parts.

Manufacturers:

Cooper Industries.

Elastimold.

Cable Lugs:

In accordance with NEMA CC1.

Rated 15kV of same material as conductor metal.

Manufacturers and Products, Uninsulated Compression Connectors and Terminators:

Burndy, Hydent.

Thomas & Betts; Color-Keyed.

ILSCO.

Terminal Blocks and Enclosures

Provide enclosures for all indoor and outdoor terminal block applications in accordance with ENVIRONMENTAL CONDITIONS in this section..

Type: Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals.

Yokes and Clamping Screws: Zinc-plated, hardened steel.

Rating: 600V ac.

Pushbuttons and Selector Switches

NEMA ICS 2, Type 600.

Type: Heavy-duty, oiltight.

Lockout: Pushbuttons and selector switches shall lock in OFF position wherever lockout provisions are indicated.

Nameplates:

Individual, large, laminated plastic.

Function indicated.

Pushbutton station nameplates shall indicate the drive controlled.

Manufacturers and Models:

Square D; Type T.

Cutler-Hammer; Type 10250T.

General Electric.

Luminaires

Specific requirements relating to fixture type, lamp type, poles, and mounting hardware are located in the Luminaire Schedule attached to this section**.**

Receptacles

NEMA WD 1 and FS W-C-596.

Specification Grade:

Type: Three-wire grounding, with screw type terminals suitable for No. 10 AWG wire. Contact to be made on two sides of each inserted blade without detent.

Number of Poles: Two.

Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.

Base: Phenolic composition.

Color: Gray.

Special Outlets

Weatherproof outdoor heavy duty circuit breaking receptacle assembly and housing.

One matching plug with cord-grip features for each special purpose outlet.

Rating: 100-amp rating, 600 volts, three-phase, three-wire with ground (four-pole) as required for anticipated purpose.

Manufacturer and Model:

Crouse-Hinds, Arktite Style 2 AREA10425.

Or equal.

Switches

NEMA WD 1 and FS W-S-896E.

Totally enclosed, ac type, quiet tumbler switches, with screw terminals.

Capable of control of 100 percent tungsten filament and fluorescent lamp loads.

Rating: 20 amps, 120/277 volts (single and double-pole as required).

Color: Gray.

Boxes

Small Standard Boxes: NEMA 250, Type 1, minimum 2 inches deep, unless shallower required by structural conditions.

Large Galvanized Steel Boxes: NEMA 250, Type 12 unless otherwise noted.

14-gauge, with full access screw covers mounted with corrosion-resistant machine screws.

Large Cast Metal Boxes: NEMA 250, Type 4, (Type 7 for combined sumps), cast malleable iron, with hot-dip galvanized finish.

Neoprene gasketed, watertight, with cast metal covers, stainless steel screws, and drilled and tapped conduit entrances.

Handholes: Reinforced cast concrete boxes sized to provide adequate working space as required by standard procedures and NFPA 70.

Nonmetallic:

Box: PVC.

Cover: PVC, weatherproof, with stainless steel screws.

Manufacturer and Product: Carlon; Type FS or FD, with Type E98 or E96 covers.

Large Nonmetallic Box: NEMA 250, Type 4X.

Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.

Cover: Hinged with clamps.

Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.

Conduit hubs and mounting lugs.

Manufacturers and Products:

Crouse-Hinds; Type NJB.
Carlon; Series N, C, or H.
Robroy Industries.

Metal Wireways

Meet requirements of UL 870.

Type: Steel-enclosed, with removable, hinged cover.

Rating: Reference ENVIRONMENTAL CONDITIONS in this section.

Finish: Gray, baked enamel.

Manufacturers:

Circle AW.
Hoffman.
Square D.

Cover Plates

Metal:

Material: Specification grade, one-piece, stainless steel.

Thickness: Minimum 0.40-inch nominal.

Finish: No. 302/304 satin.

Mounting Screws: Oval head, stainless steel, to match plate.

Cast Metal:

Material: Malleable ferrous, with gaskets.

Mounting Screws: Oval head, stainless steel.

Weatherproof Device Plates:

Material: Cast metal, gasketed, weatherproof, with individual cap over each opening held with stainless steel springs.

Finish: Stainless steel or fiberglass reinforced plastic.

Mounting Screws: Stainless steel.

Grounding

General

Grounding shall be in compliance with NFPA 70 and ANSI C2.

Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, metal piping systems, and metal structures which may become energized by attached electrical devices (i.e., leachate storage tank, metal frame of buildings).

Shielded Instrumentation Cables:

Ground shield of instrumentation cables at PLC end only, using drain wire connected to terminal block that is connected to an isolated instrument ground. Isolated instrument ground terminals block is located inside PLC control panel enclosure.

Insulate ungrounded end of all shielded instrumentation cables' shield with shrink tubing for a distance of 1/2 inch either side of the end of the outer jacket.

Wire Connections:

Ground Conductors: Install in conduit containing power conductors and control circuits.

Nonmetallic Raceways and Flexible Tubing:

Install equipment grounding conductor and bond at both ends.

Connect ground conductors to raceway grounding bushings.

Bond all equipment grounding conductors to equipment ground bus and equipment enclosures as required by the NEC.

Bolt connections to equipment ground bus.

Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

Motor Grounding: Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor and bond at both ends.

Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

Grounding Conductors:

Equipment: Solid or stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

Direct Buried: Bare stranded copper.

Isolated Instrument Ground: Stranded copper with green insulation with yellow stripe or yellow phasing tape at all ends.

Ground Rod:

Material: Copper.

Diameter: Minimum 3/4 inch.

Length: 10 feet.

Connectors:

Exothermic Weld Type:

Outdoor Weld: Suitable for exposure to elements or direct burial.

Indoor Weld: Utilize low-smoke, low-emission process.

Manufacturers: Erico Products, Inc., Cadweld and Cadweld Exolon.

Compression Type:

- Compress-deforming type; wrought copper extrusion material.
- Single indentation for conductors 6 AWG and smaller.
- Double indentation with extended barrel for conductors 4 AWG and larger.
- Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.

Manufacturers:

- Burndy Corp.
- Thomas and Betts Co.
- ILSCO Corp.

Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

Manufacturers:

- Burndy Corp.
- Thomas and Betts Co.
- ILSCO Corp.

Grounding Wells:

Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

Manufacturers and Products:

Christy Co.; No. G5.

Lightning and Grounding Systems, Inc.; I-R Series.

Part 3 – Execution

General

All work shall be performed in a neat and workman-like manner and shall comply with all applicable provisions of NECA 5055 standards and practices.

Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the hazardous area indicated.

Ground equipment, enclosures, and complete conduit system securely in accordance with applicable sections of NFPA 70.

Panelboards and Mini-Power Centers

Install securely, plumb, in-line and square with walls.
Install top of cabinet 6 feet above floor, unless otherwise shown.
Provide typewritten circuit directory for each panelboard.

Cabinet Location/Type:

Industrial Use in Areas Not Otherwise Classified: Reference ENVIRONMENTAL CONDITIONS in this section.

Transient Voltage Surge Suppression (TVSS) Equipment

Install in accordance with manufacturer's instructions, including lead length, overcurrent protection, and grounding.

Motor Starter

Field adjust trip settings of motor starter magnetic, trip-only circuit breakers in accordance with manufacturer's instructions.

Conduit And Fittings

General:

Conduit system shall be carefully planned with proper attention to details before starting the work.
Do not install crushed or deformed raceways. Replace any raceway that has been damaged after installation.

Raceways that are installed so as to form a moisture trap are not allowed.
Prevent plaster, dirt, or trash from lodging in raceways, boxes, fittings, and equipment during the course of construction. Clear clogged raceways of obstructions.
All conduit runs shall be made parallel to or perpendicular to the lines of the building.

Secure conduits entering cabinets, pull boxes or outlet boxes with galvanized locknuts and bushings, on both sides of box wall.

Identify conduits at each terminus using conduit and cable schedule designations.

Applications:

Exposed Exterior: Type RGS.

Concrete Embedded: Type PVC.

Direct Buried: Type PVC inside concrete duct bank.

Vertical Runs Through Slab on Grade: Convert PVC conduit to RGS wrapped with watertight adhesive plastic tape.

PVC Bends: Bends in PVC runs shall be incorporated using RGS. RGS wrapped with watertight adhesive plastic tape.

Final Connection to Motors:

Conduit Size 4 Inches or Less: 18-inch minimum, 60-inch maximum length of flexible liquid-tight metal conduit.

Penetrations:

Conduits penetrating fire-rated walls shall be sealed with a compound approved by UL and appropriate to the fire rating of the wall.

Flash and counterflash conduits penetrating roofing membrane.

Seal penetrations with oakum or expandable plastic compound.

Provide sleeves and chases where conduits pass through floors or walls. Finish to match adjacent surfaces.

Provide escutcheon plates where exposed conduits pass through walls, floors or ceilings.

Conduits from the combined sump area shall be sealed with a compound approved by UL, and appropriate for conduits in hazardous areas entering nonhazardous areas.

Slab-On-Grade or Direct Buried:

Install horizontal runs below floor slab. Horizontal runs within slab shall not be permitted.

Field wrap RGS conduit and joints installed below slab or direct buried with 0.010-inch thick pipe wrapping plastic tape applied with a 50 percent overlay, or factory apply a plastic resin, epoxy, or coal-tar coating system.

Exposed Raceways:

Install parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

Underground Duct Banks:

All underground duct banks shall be installed in locations shown on drawings, enclosed in a red concrete casing as specified in Section 03301, CONCRETE. The concrete casing shall also enclose all standard conduit bends or elbows. All underground ducts shall have steel reinforcement in sizes as shown on the drawings.

Excavate the trenches as specified in Section 02316, EXCAVATION, to provide elevation on top of concrete envelope as shown on drawings. After trenches are excavated and graded, the duct shall be laid in rows on plastic spacers or approved equals.

Spacers shall be placed so that each section of duct is supported at intervals as specified in NFPA 70 (NEC). Concrete shall then be placed per Section 03301, CONCRETE, until the ducts are covered to the required depth and leveled, leaving NOT less than 4 inches of concrete over top tier of ducts. Backfill shall be in accordance with Section 02320, TRENCH BACKFILL.

Changes in Direction of Runs:

Make with symmetrical bends or cast metal fittings.

Bends and offsets shall be made with a hickey or conduit bending machine.

Supports:

Provide pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps with retainers, or ceiling trapeze.

Install suitable braces for conduit, junction boxes, light fixtures and other electrical equipment as needed for seismic support.

Securely and rigidly fasten in place.

Maximum Interval: 10 feet.

Precast Utility Vaults, Manholes and Handholes

Excavate, shore, brace, backfill, and final grade in accordance with Section 02316, EXCAVATION and Section 02320, TRENCH BACKFILL.

Do not install until final raceway grading has been determined.

Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

Conductors

Conduit system shall be complete prior to drawing conductors.

Lubricate prior to drawing into conduit. Lubrication type shall be as approved by conductor manufacturer.

Connections: Pressure type solderless, complete with insulator and security ring.

Control Circuits:

Where multiple units perform parallel operations, do not group all devices on same branch circuit.

Do not exceed the ampacity of the branch circuit, or 12 amperes continuous.

Terminate feeder and interconnecting conductors between panel mounted equipment and external equipment at numbered terminal blocks.

Identification:

Where two or more conduits run to a single outlet box, color code each circuit as a guide in making connections.

Carry colors continuously throughout the system.

Do not install multiwire branch circuits that share a common neutral.

Identify conductors, cables at each terminus, and handhole using conduit and cable schedule designations.

Colors:

Confirm and utilize the existing Hanford field center color coding system as shown below:

Conductor Origin: 480Y/277-volt, three-phase system. Transformers, panels, switchboard, etc.

Phase A	Red
Phase B	Yellow
Phase C	Blue
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: 208Y/120-volt, three-phase system. Transformers, panels, switchboard, etc.

Phase A	Black
Phase B	Purple
Phase C	Brown
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: 120/240-volt, single-phase system. Transformers, panels, switchboard, etc.

Hot Number 1	Black
Hot Number 2	Brown
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: DC system. Instruments, control panels, etc.

DC+	Red
DC-	Black

Conductors Above 600 Volts (Schedule A Work Only)

Do not splice conductors.

Single Conductor Cable Terminations:

Coordinate all terminations with FH EU.

Make terminations with termination kits, in accordance with kit manufacturer's instructions. Install terminations as continuous operation in accessible locations under clean, dry conditions.

Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing plus a ground braid and clamp.

Install terminals or connectors acceptable for type of conductor material used.

Provide shield termination and grounding for all terminations.

Provide necessary mounting hardware, covers, and connectors.

Where elbow connectors are specified, install in accordance with manufacturer's instructions.

Connections and Terminations:

Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

Give 2 working day's notice to FH EU prior to making terminations.

Terminal Blocks

Install for termination of all control circuits leaving or entering equipment, panels, or boxes.

Luminaires

Install luminaires and poles in accordance with manufacturer's recommendations.

Install plumb and true.

Provide swivel type hangers and canopies to match pendant mounted fixtures.

Furnish all lamps and clean the reflectors, the diffusers, and the lamps before closing up the fixtures.

Boxes

Support to the structure, independent of conduit attachment.

Boxes installed belowgrade shall be installed flush with finished grade.

Boxes and covers in paved areas, roadways, or walkways shall be suitable for weights to which they may be subjected.

Box Extensions: Not permitted.

Classified Hazardous Areas: Boxes shall be applicable for location.

Cover Plates

Shall fit tightly to box.

Shall not extend beyond sides of box on surface mounted boxes, unless covers have no sharp corners or edges.

Trench Backfill

In accordance with Section 02320, TRENCH BACKFILL.

Protection Following Installation

Protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation.

Cap conduit runs during construction with manufactured seals.

Close openings in boxes or equipment during construction.

Energize space heaters furnished with equipment.

Construction Quality Control

In accordance with Section 16080, ELECTRICAL TESTING, and as specified herein.

Circuit Balance: Confirm the balance of electrical load between phases on three-phase panelboards and motor control centers after installation. Notify Construction Manager of current unbalances 10 percent and greater.

Voltage Testing: When installation is complete and facility is in operation, check voltage at point of termination of electric supply system to project.

Check voltage amplitude and balance between phases for loaded and unloaded conditions.

Record supply voltage for 24 continuous hours. If unbalance exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded conditions more than plus or minus 4 percent of nominal, make written request to Tank Farm Contractor to correct condition.

Equipment Line Current:

Check line current in each phase for each piece of equipment.

If electric utility makes adjustments to supply voltage magnitude or balance, make line current check after adjustments are made.

Inspection of Low Voltage Cables, 600 Volts Maximum (Note: FH EU shall inspect and test all cables rated above 600 volts):

Inspect each individual exposed power cable for physical damage, proper connections in accordance with Section 16080, ELECTRICAL TESTING.

Electrical Tests for Conductors (600 Volts and Below):

Prior to final connection and energizing of power and control circuits, conduct an insulation resistance test to determine insulation integrity in accordance with Section 16080, ELECTRICAL TESTING.

Ground Electrode Test:

Inspect grounding connections prior to any backfill of cables in accordance with Section 16080, ELECTRICAL TESTING.

Maximum ground electrode resistance shall be 3 ohms. Add maximum 2 additional ground rods spaced 6 feet apart if 3 ohms is not achieved.

Supplements

The supplement listed below, following "END OF SECTION," is a part of this Specification.

Supplement 1—Luminaire Schedule.

END OF SECTION 16005

Luminaire Schedule						
Type	**Voltage**	**Description**	**Manufacturer**	**Catalogue No.**	**Lamp**	**Mounting Type**
1	120	Heavy duty industrial 4-foot fluorescent fixture with 2 lamps with low temp electronic starting ballast(s).	Holophane	7200-4-12-LT Fluorescent Prismatite or equal.	2-40W R.S. T12, 0°F starting (48″)	Pendant with chains and surface mount
2	120	Standby light NiCaD battery operated.	Holophane	C1-6N-25-W-WCHY-2 Cortez A1	2-12 watts 6-volt Halogen	Wall mount
3	120	WallPack wall mount HPS with integral photocell.	Holophane	WallPack WL2K-070HP-12-BK—F1-LAMP-PC	1-70W HPS	Wall mount
4	120	Pole mount outdoor flood wet location duty. Single and double 2U configuration as indicated.*	Holophane	Predator Floodlight PF-250HP-12-K-W-1-B-CR[2]	250-watt HPS	Pole mount round tapered steel poles, single and 2U configurations SPRT20J/1/SG SPRT20J/2/SG
5	120	Crestwood outdoor post light with HPS fixture and cover*	Holophane	Crestwood CW-24-15AHP-12-GR-CA	1-150W HPS	Round tapered steel galvanized pole 10 foot SPRT10J/SG
Note: *Install added vertical light cutoff "shades."						

1

SECTION 16055 – PIPE HEAT TRACING SCHED. B

Part 1 – General

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data: Manufacturer's descriptive literature.

Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.

Pipe heat loss calculations for each pipe size to be heat traced.

Submittals–Approval Not Required

Information/Record (IR):

Field Testing: Submit inspection/test report on insulation resistance per CONSTRUCTION QUALITY CONTROL section of this Specification.

Part 2 – Products

System Design Requirements

Design Heating Load:

Heating load to be calculated based upon a 100-degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 15060, PIPING-GENERAL, and shall include a 10 percent safety factor.

Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

Electrical Heating Tape

Cable: Auto-trace, self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

Minimum Maintenance Temperature: Minus 40 degrees F (-40 degrees C).

Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings. All heat trace circuits shall be powered by ground fault interrupter type (GFEP) circuit breakers (30 mA).

Manufacturers and Products:

Raychem; Chemelex BTV or BRV-C.

Thermon; FLX-BC or FLX-OJ.

Nelson; CL1-J1 or L1-J1.

Connection System

Rating: NEMA 250, Type 4 and Factory Mutual approved.

Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

Manufacturers and Products:

Power Connection Kit:

Raychem; Chemelex AM-BC.
Thermon; PCA-COM.
Nelson; PLT-BC.

Splice Kit:

Raychem; Chemelex AM-BS.
Thermon; PCS-COM.
Nelson; PLT-BS.

Tee Kit:

Raychem; Chemelex AM-B4.
Thermon; Tee Snap.
Nelson; PLT-BY.

End Seal Kit:

Raychem; Chemelex AM-E.
Thermon; ET-6C or ET-8C.
Nelson; LT-ME.

Pilot Light:

Raychem; Chemelex AM-L.
Thermon; VIL-4C.
Nelson; LT-L.

Pipe Adapter Kit:

Raychem; Chemelex AM-P or AM-T.
Thermon; included with power connection kit.
Nelson; LT-P.

Securing Tape

Plastic Piping Systems:

Type: Aluminum foil coated adhesive tape.

Manufacturers and Products:

Raychem; Chemelex AT-180.

Thermon; AL-20P.

Nelson; AT-50.

Metallic Piping Systems:

Type: Glass or polyester cloth pressure sensitive tape.

Manufacturers and Products:

Raychem; Chemelex GS54 or GT66.

Thermon; PF-1.

Nelson; GT-6 or GT-60.

Ambient Thermostat

Type: Adjustable setting (15 to 140 degrees F), set to 40 degrees F, so as to switch cable off when ambient temperature exceeds 40 degrees F.

Sensor: Fluid-filled probe.

Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

Manufacturers and Products:

Raychem; Chemelex Model AMC-1A.

Thermon; B4X-15140.

Nelson; TX-4X140.

Part 3 – Execution

Installation

General:

Install in accordance with the manufacturer's instructions and recommended practices.

Provide insulation as specified in Section 15060, PIPING-GENERAL, over all pipe heat tracing.

Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.

Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.

Provide end of circuit pilot lights on heat tracing circuits for buried piping.

Electrical Heating Tape:

Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.

Where design heating load exceeds heating tape capacity, install by spiraling.

Derate heating tape capacity when installed on plastic piping.

Install on services as follows (reference Drawings H-2-830854, Sheets 2 and 4):

Service	Piping Material	Placement	Location
Cell No. 1	3″ LH-030-HDPE	Heat trace and insulate exposed portion of piping from tank inlet connection to about 2 feet below grade.	Cell No. 1 and Cell No. 2
Cell No. 2	3″ LH-030-HDPE		Leachate Storage Tank(s) Process Inlet Connections.
Cell No. 1	4″ LT-034-PVC	Heat trace and insulate exposed portion of piping from tank inlet connection to about 2 feet below grade.	Cell No. 1 and Cell No. 2
Cell No. 2	4″ LT-034-PVC	Connections	Outlet
Cell No. 1	4″ LH-045-HDPE	Heat trace and insulate exposed portion of piping from tank inlet	Cell No. 1 and Cell No. 2
Cell No. 2	4″ LH-045-HDPE	Connection to about 2 feet below grade.	Leachate Storage Tank(s) Process Inlet Connections.
Cell No. 1	4″LT-037-HDPE	Heat trace and insulate exposed portion of piping from above grade	Cell No. 1 and Cell No. 2 Truck
Cell No. 2	4″LT-037-HDPE	Connection fittings to about 2 feet below grade, including 8″ containment piping.	Loading Station(s) Process to Truck Connections.

Wrap heat trace cable once every 33 inches under pipe insulation. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

Thermostats: Install in accordance with manufacturer's instructions and as approved by Engineer.

For each group of heat traced circuit, install one ambient thermostat.

Construction Quality Control

In accordance with Section 16080, ELECTRICAL TESTING, and as specified herein.

Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION 16055

SECTION 16080 – ELECTRICAL TESTING SCHED. A &B

Part 1 – General

Fluor Hanford Electrical Utilities (FH EU) shall test pad mounted transformer and conductors rated above 600 volts. Construction General Contractor shall coordinate FH EU testing with Construction Manager.

Onsite testing shall be required for each major electrical system as specified herein in the presence of representatives for the authority having jurisdiction (AHJ). Tests shall be performed to demonstrate that each function is implemented and operational. These tests are electrical component tests to be performed in advance of facility-wide construction acceptance testing (CAT). CAT shall be performed in accordance with Division requirements.

Provide personnel and equipment in support of Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), Operation Readiness (ORT) and Performance Acceptance (PAT) testing.

Approval By Authority Having Jurisdiction (AHJ)

As specified in Section 16005, ELECTRICAL.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Qualifications: Submit Testing Firm Qualifications as specified herein.

Submittals–Approval Not Required

Information/Record (IR):

Submit 30 days prior to performing inspections or tests:

Schedule for performing inspection and tests.

List of references to be used for each test.

Sample copy of equipment and materials inspection form(s).

Sample copy of individual device test form.

Sample copy of individual system test form.

Submit within 30 days after completion of test:

Test or inspection reports and certificates for each electrical item tested.

Operation and Maintenance Data:

After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in operation and maintenance manual.

Testing Firm Qualifications

Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years' testing experience on similar projects.

Technicians certified by NICET or NETA.

Registered professional engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.

In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories.

Sequencing And Scheduling

Perform inspection and electrical tests after equipment has been installed. Construction General Contractor shall coordinate NEC required inspections and Fluor Hanford Electrical Utilities (FH EU) required testing and inspections with Construction Manager. Tank Farm Contractor will provide services of an NEC inspector.

Perform tests with apparatus de-energized whenever feasible.

Inspection and electrical tests on energized equipment are to be:

- Scheduled with Construction Manager prior to de-energization.
- Minimized to avoid extended period of interruption to the operating plant equipment.

Notify Construction Manager at least 24 hours prior to performing tests on energized electrical equipment.

Part 2 – Products

Test Equipment/Instrumentation Requirements:

Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

Test instrument calibration shall be in accordance with NETA ATS.

Part 3 – Execution

General:

Tests and inspection shall establish that:

- Electrical equipment is operational within industry and manufacturer's tolerances.
- Installation operates properly.
- Equipment is suitable for energization.
- Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.
- Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- Adjust mechanisms and moving parts for free mechanical movement.

Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

Verify nameplate data for conformance to Contract Documents.

Realign equipment not properly aligned and correct unlevelness.

Properly anchor electrical equipment found to be inadequately anchored.

Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

Provide proper lubrication of applicable moving parts.

Inform Construction Manager of working clearances not in accordance with NFPA 70.

Investigate and repair or replace:

Electrical items that fail tests.

Active components not operating in accordance with manufacturer's instructions.

Damaged electrical equipment.

Electrical Enclosures:

Remove foreign material and moisture from enclosure interior.

Vacuum and wipe clean enclosure interior.

Remove corrosion found on metal surfaces.

Repair or replace, as determined by Construction Manager, door and panel sections having dented surfaces.

Repair or replace, as determined by Construction Manager, poor fitting doors and panel sections.

Repair or replace improperly operating latching, locking, or interlocking devices.

Replace missing or damaged hardware.

Finish:

Provide matching paint and touch up scratches and mars.

If required due to extensive damage, as determined by Construction Manager, refinish the entire assembly.

Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

Dry Type Transformers

Visual and Mechanical Inspection:

Physical and insulator damage.

Proper winding connections.

Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

Defective wiring.

Proper operation of fans, indicators, and auxiliary devices.

Removal of shipping brackets, fixtures, or bracing.

Free and properly installed resilient mounts.

Cleanliness and improper blockage of ventilation passages.

Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.

Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

Winding-to-winding.

Winding-to-ground.

10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

Insulation resistance test results to compare within 1 percent of adjacent windings.

Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

Low Voltage Cables, 600 Volts Maximum:

Visual and Mechanical Inspection:

Inspect Each Individual Exposed Power Cable No. 8 and Larger For:

Physical damage.

Proper connections in accordance with single-line diagram.

Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

Color coding conformance with specifications.

Proper circuit identification.

Mechanical Connections For:

Proper lug type for conductor material.

Proper lug installation.

Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

Shielded Instrumentation Cables For:

Proper shield grounding.

Proper terminations.

Proper circuit identification.

Continuity test by ohmmeter method to ensure proper cable connections.

Control Cables For:

Proper termination.

Proper circuit identification.

Continuity test by ohmmeter method to ensure proper cable connections.

Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

Electrical Tests for Conductors No. 8 and Larger:

Insulation Resistance Tests:

Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.

Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.

Evaluate ohmic values by comparison with conductors of same length and type.

Investigate values less than 50 megohms.

Continuity test by ohmmeter method to ensure proper cable connections.

Safety Switches, 600 Volts Maximum

Visual and Mechanical Inspection:

Proper blade pressure and alignment.

Proper operation of switch operating handle.

Adequate mechanical support for each fuse.

Proper contact-to-contact tightness between fuse clip and fuse.

Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.

Proper phase barrier material and installation.

Verify that fuse sizes and types correspond to one-line diagram.

Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.

Phase-to-phase and phase-to-ground for 1 minute on each pole.

Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

Contact Resistance Tests:

Contact resistance in microhms across each switch blade and fuse holder.

Investigate deviation of 50 percent or more from adjacent poles or similar switches.

Molded And Insulated Case Circuit Breakers

General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 30 amperes and larger.

Visual and Mechanical Inspection:

Proper mounting.

Proper conductor size.

Feeder designation according to nameplate and one-line diagram.

Cracked casings.

Connection bolt torque level in accordance with NETA ATS, Table 10.1.

Operate breaker to verify smooth operation.

Compare frame size and trip setting with circuit breaker schedules or one-line diagram.

Verify that terminals are suitable for 75 degrees C rated insulated conductors.

Electrical Tests:

Insulation Resistance Tests:

Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.

Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute

Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

Test values to comply with NETA ATS, Table 10.2.

Contact Resistance Tests:

Contact resistance in microhms across each pole.

Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

Current Injection Test to Verify:

Long-time minimum pickup and delay.

Short-time pickup and delay.

Instantaneous pickup by run-up or pulse method.

Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

Trip times shall be within limits established by NEMA AB 4, Table 5-3.

Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

Instrument Transformers

Visual and Mechanical Inspection:

Visually Check Current, Potential, and Control Transformers For:

Cracked insulation.

Broken leads or defective wiring.

Proper connections.

Adequate clearances between primary and secondary circuit wiring.

Verify Mechanically That:

Grounding and shorting connections have good contact.

Withdrawal mechanism and grounding operation, when applicable, operate properly.

Verify proper primary and secondary fuse sizes for potential transformers.

Electrical Tests:

Current Transformer Tests:

Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.

Polarity test.

Potential Transformer Tests:

Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:

Winding-to-winding.

Winding-to-ground.

Polarity test to verify polarity marks or H1-X1 relationship as applicable.

Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

Utility Metering:

Testing to be conducted by FH EU.

Grounding Systems:

Visual and Mechanical Inspection:

Equipment and circuit grounds in motor control center and panelboard assemblies for proper connection and tightness.

Ground bus connections in motor control center and panelboard assemblies for proper termination and tightness.

Effective transformer core and equipment grounding.

Accessible connections to grounding electrodes for proper fit and tightness.

Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

Electrical Tests:

Fall-Of-Potential Test:

In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.

Main ground electrode system resistance to ground to be no greater than 3 ohms.

Two-Point Direct Method Test:

In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.

Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohm.

AC Induction Motors

General: Inspection and testing limited to motors rated 1/3 hp and larger.

Visual and Mechanical Inspection:

- Proper electrical and grounding connections.
- Shaft alignment.
- Blockage of ventilating air passageways.

Operate Motor and Check For:

- Excessive mechanical and electrical noise.
- Overheating.
- Correct rotation.
- Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
- Excessive vibration.
- Check operation of space heaters.

Electrical Tests:

Insulation Resistance Tests:

In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:

- Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
- Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
- Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
- Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

Low Voltage Motor Control

Visual and Mechanical Inspection:

- Proper barrier and shutter installation and operation.

Proper operation of indicating and monitoring devices.

Proper overload protection for each motor.

Improper blockage of air cooling passages.

Proper operation of drawout elements.

Integrity and contamination of bus insulation system.

Check Breaker and Kirk Key Interlocking System By:

Closure attempt of breaker when associated Kirk key is in place.

Open attempt of breaker when associated Kirk key is in place.

Closure attempt of breaker when associated Kirk key is not in place.

Open attempt of breaker when associated Kirk key is not in place.

Check Door and Device Interlocking System By:

Closure attempt of device when door is in OFF or OPEN position.

Opening attempt of door when device is in ON or CLOSED position.

Check Nameplates for Proper Identification Of:

Equipment title and tag number with latest one-line diagram.

Control switches.

Pilot lights.

Control relays.

Circuit breakers.

Verify that fuse and circuit breaker sizes and types conform to Contract Documents.

Verify that current and potential transformer ratios conform to Contract Documents.

Check Bus Connections for High Resistance by Low Resistance Ohmmeter: Ohmic value to be zero.

Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:

Closure attempt for locked open devices.

Opening attempt for locked closed devices.

Key exchange to operate devices in OFF-NORMAL positions.

Verify performance of each control device and feature furnished as part of the motor control center.

Control Wiring:

Compare wiring to local and remote control, and protective devices with elementary diagrams.

Check for proper conductor lacing and bundling.

Check for proper conductor identification.

Check for proper conductor lugs and connections.

Exercise active components.

Inspect Contactors For:

Correct mechanical operations.

Correct contact gap, wipe, alignment, and pressure.

Correct torque of all connections.

Compare overload settings and voltage ratings with full-load current for proper size.

Compare fuse motor protector and circuit breaker with motor characteristics for proper size.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.

Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

Contactor phase-to-ground and across open contacts for 1 minute on each phase.

Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.

Test values to comply with NETA ATS, Table 10.2.

Overpotential Tests:

Maximum applied ac or dc voltage in accordance with NETA ATS, Table 7.1.2.

Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.

Test results evaluated on pass/fail basis.

Current Injection Through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:

Trip time in accordance with manufacturer's published data.

Investigate values in excess of 120 seconds.

Control Wiring Tests:

Apply secondary voltage to control power and potential circuits.

Check voltage levels at each point on terminal boards and each device terminal.

Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.

Insulation resistance to be 1 megohm minimum.

Operational test by initiating control devices to affect proper operation.

Low Voltage Surge Arrestors

Visual and Mechanical Inspection:

Adequate clearances between arrestors and enclosures.

Ground connections to ground bus and electrode.

Electrical Tests:

Varistor Type Arrestors:

Clamping voltage test.

Rated RMS voltage test.

Rated dc voltage test.

Varistor arrestor test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

END OF SECTION 16080

SECTION 16270 – OIL-FILLED PAD MOUNTED TRANSFORMERS SCHED. A

Part 1 – General

References

The following is a list of standards, which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ANSI C57.12.22	Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller
ANSI C57.12.26	Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment, Enclosure Integrity
ANSI C57.12.90	Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE C62.11	Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 KV)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

- Descriptive information.
- Dimensional drawings.
- Transformer nameplate data.
- Schematic and connection diagrams.
- Factory test reports certified.

Submittals–Approval Not Required

Information/Record (IR):

- Operation and maintenance data.
- Material Safety Data Sheet (MSDS) for Envirotemp FR3™ Fluid.
- Submit documentation and test results from construction quality control testing.

Extra Materials

Furnish, tag, and box for shipment and storage and deliver prior to 30 percent Project completion the following spare parts, special tools, and materials:

One quart of paint to match color and quality of equipment final shop finish.

Two spare fuse links for each fuse size.

Part 2 – Products

Source Quality Control (Factory Tests)

Design, test, and assemble in accordance with applicable standards of ANSI C57.12.00, C57.12.22, C57.12.26, and C57.12.90.

Production tests in accordance with ANSI C57.12.90 and C57.12.00, Section 8 and Table 16.

Dielectric test in accordance with ANSI C57.12.26.

Manufacturers

Cooper Power System.

Cutler-Hammer.

Square D Co.

General Electric.

General

Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

Transformer

kVA Rating: 112.5.

Primary Voltage: 13.8 kV line-to-line, three-phase, 60 Hz.

Secondary Voltage: 480/277 volts, three-phase, four-wire, 60 Hz.

BIL Rating:

95 BIL for 15 kV insulation class transformers.

30 BIL for secondary.

Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

Impedance: 3.2 percent.

Coolant: Normally formulated, hydro-refined oil free of PCB chemical, FMRC approved, UL classified less-flammable Envirotemp FR3, in accordance with FMRC 3990. Fluid shall have a minimum open cup fire point of 350 degrees C and a minimum 5-day BOD (SM5210B) of 200 ppm. Manufacturer is to provide information on the transformers nameplate that it is "NON-PCB" along with "manufacturer's name and type of insulating fluid."

Primary Taps:

Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.

Externally operated no-load tap changer.

Provisions for locking handle in any position.

Coil Conductors: Copper windings.

Delta-wye transformers wound on triplex cores.

Sound Level: In accordance with manufacturer's standards.

Enclosure

In accordance with ANSI C57.12.28 requirements.

Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.

12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

Corrosion Protection and Color: Base(s) and cabinet(s) of the transformer shall be corrosion resistant and shall be fabricated of steel. Provide insulating and corrosion resistance undercoating on base of transformer. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. The Munsell color notation is specified in ASTM D1535.

Terminal Compartments

General: ANSI C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

Doors:

Individual, full-height, air-filled.

Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.

High voltage door fastenings inaccessible until low voltage door has been opened.

Door Bolts:

Hex-head type.

Lift-off, stainless steel hinges and door stops.

Removable front sill to facilitate rolling or skidding over conduit stub ups.

Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

High Voltage Compartment:

Deadfront in accordance with ANSI C57.12.26 type construction.

Protective fuses.

High voltage bushings.

Transformer grounding pad.

Surge arrestors with barriers.

Four-position, oil-immersed type switch to permit closed transit in loop feed and sectionalizing position sectionalizing load-break switch.

Parking stands.

Low Voltage Compartment:

Livefront in accordance with ANSI C57.12.26 type construction.

Low voltage bushings.

Grounding pad.

Stainless steel equipment nameplate.

Liquid level gauge.

1-inch upper filter press and filling plug.

Drain valve with sampling device.

Dial type thermometer.

Pressure relief valve.

Pressure relief device, self-resealing with indicator.

Pressure-vacuum gauge.

Mounting provision for current and potential transformers.

Nameplate per Nameplate C, Table 9, IEEE C57.12.00.

Bushings

High Voltage:

Deadfront Termination:

Universal bushing well rated at 15 kV in accordance with ANSI 386.

Bushings externally clamped and front removable.

Rated for 200 amperes continuous, 95 kV BIL.

Standoff brackets located adjacent to bushings.

Low Voltage:

Molded epoxy bushing clamped to tank with 4 hole spade type terminals.

Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.

Internally connected neutral extending to neutral bushing.

High Voltage Switching

Internal, oil-immersed, gang-operated load-break, manually operated switches.

Hot stick operated handle located in high voltage compartment.

Capable of operating at full-load current.

Feed Switch: Four-position, oil-immersed type switch to permit closed transition loop feed and sectionalizing. Switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. The switch handle shall be located in the high-voltage compartment and lockable in the ON/OFF position. Switch shall be similar to the Cooper Power Systems, Electrical Apparatus 800-64, Sectionalizing Switches, "T" blade switch.

High Voltage Protection

Combination Oil-Immersed Bayonet Expulsion and Current Limiting Fuses:

Accessibility:

Bayonet expulsion fuse accessible through primary compartment.

Current-limiting fuse accessible through tank handhole.

Expulsion Fuse for Low Current Faults: Interrupting capacity of 1,800 amperes rms asymmetrical.

Current Limiting for High Current Faults:

Interrupting capacity of 50,000 amperes rms symmetrical.

Bayonet fuse externally replaceable with hot stick.

Bayonet fuse links shall be dual sensing for both high currents and high oil temperature in order to provide thermal protection to the transformer.

Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse.

In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing, which closes when the fuse holder is removed and an external drip shield.

Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the OPEN position and the tank pressure has been released.

Bayonet Fuse Assembly: 150 kV BIL.

Oil-Immersed Current-Limiting Fuses: NEMA C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

Surge Arrestors

Metal-Oxide, Varistor Type:

Insulated body, elbow type, 18 kV in accordance with IEEE C62.11.

Installed in high voltage compartment.

Connected to transformer high voltage bushing wells.

Tank Grounding Pads

Low Voltage Compartments:

Connected together with bare No. 2/0 stranded copper conductors.

Wye low voltage neutral internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.

Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

Tap Changer Warning Sign

Red laminated plastic, engraved to white core.

Engrave to read DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

Mount above tap changer handle.

Part 3 – Execution

General

Prepare subgrade for utility vault for pad mounted transformer as specified in Section 02319, SUBGRADE PREPARATION, paragraph "Prepared Subgrade for Roadway, Embankment and Structures."

Secure to mounting pads with anchor bolts.

Install plumb and longitudinally in alignment with pad or adjacent building wall.

Ground neutrals and enclosures in accordance with applicable codes and as shown on the Drawings.

Construction Quality Control

In accordance with Section 16080, ELECTRICAL TESTING.

Adjustments

Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION 16270

SECTION 16270-1 – SINGLE PHASE OIL-FILLED PAD MOUNTED TRANSFORMERS SCHED. B

Part 1 – General

References

The following is a list of standards which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ANSI C57.12.21	Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings, 167 kVA and Smaller
ANSI C57.12.25	Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment, Enclosure Integrity
ANSI C57.12.90	Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

- Descriptive information.
- Dimensional drawings.
- Transformer nameplate data.
- Schematic and connection diagrams.
- Factory test reports certified.

Submittals–Approval Not Required

Information/Record (IR):

- Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.
- Material Safety Data Sheet (MSDS) for Envirotemp FR3™ Fluid.
- Submit documentation and test results from construction quality control testing.

Extra Materials

Furnish, tag, and box for shipment and storage and deliver prior to 30 percent Project completion.

Part 2 – Products

Source Quality Control (Factory Tests)

Design, test, and assemble in accordance with applicable standards of ANSI C57.12.00, C57.12.21, C57.12.25, and C57.12.90.

Production tests in accordance with ANSI C57.12.90, Section 8 and Table 16.

Dielectric test in accordance with ANSI C57.12.25.

Manufacturers

Cooper Power System; Maxishrub type.

ABB.

General

Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartment, assembled on a common base.

Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

Transformer

kVA Rating: 75.

Primary Voltage: 13.8 kV line-to-line, single-phase, 60 Hz.

Secondary Voltage: 120/240 volts, single-phase, three-wire, 60 Hz.

BIL Rating:

95 BIL for 15 kV insulation class transformers.

30 BIL for secondary.

Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

Impedance: 3.2 percent, minimum.

Coolant: Normally formulated, hydro-refined oil free of PCB chemical, FMRC approved, UL classified less-flammable Envirotemp FR3, in accordance with FMRC 3990. Fluid shall have a minimum open cup fire point of 350 degrees C and a minimum 5-day BOD (SM5210B) of 200 ppm. Manufacturer is to provide information on the transformers nameplate that it is "NON-PCB" along with "manufacturer's name and type of insulating fluid."

Primary Taps:

Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.

Externally operated no-load tap changer.

Provisions for locking handle in any position.

Coil Conductors: Copper windings, insulated with B-stage, epoxy coated, diamond pattern insulating paper, thermally cured under pressure.

Sound Level: In accordance with manufacturer's standards.

Enclosure

In accordance with ANSI C57.12.28 requirements.

Welded carbon steel sealed transformer tank, with domed tank cover , and recessed stainless steel lifting eyes.

12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

Corrosion Protection and Color: Base(s) and cabinet(s) of the transformer shall be corrosion resistant and shall be fabricated of steel.

Provide insulating and corrosion resistance undercoating on base of transformer. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. The Munsell color notation is specified in ASTM D1535.

Terminal Compartment

General: ANSI C57.12.28, enclosed high and low voltage assemblies side by side, bolted to transformer tank.

Door: Hinged door with stainless steel hinge pins and barrels.

Door Bolts: Recessed, captive, penta head type.

Removable front sill to facilitate rolling or skidding over conduit stub ups.

Floating lock pocket.

High Voltage Assembly:

Deadfront in accordance with ANSI C57.12.25 type construction.

Protective fuses.

High voltage bushings.

Transformer grounding pad.

Surge arrestors with barriers.

Parking stands.

Low Voltage Assembly:

Livefront in accordance with ANSI C57.12.25 type construction.

Low voltage bushings.

Grounding pad.

Stainless steel equipment nameplate.

Liquid level gauge.

Oil filling plug.

Drain valve with sampling device.

Dial type thermometer.

Pressure relief device, self-resealing with indicator.

Pressure-vacuum gauge.

Nameplate per Nameplate A, IEEE C57.12.00.

Bushings

High Voltage:

Deadfront Termination:

Universal bushing well rated at 15 kV in accordance with ANSI 386.

Bushings externally clamped and front removable.

Rated for 200 amperes continuous, 95 kV BIL.

Standoff brackets located adjacent to bushings.

Low Voltage:

Molded epoxy bushing clamped to tank with 4 hole spade type terminals.

Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.

High Voltage Protection

Combination Oil-Immersed Bayonet Expulsion and Current Limiting Fuses:

Accessibility:

Bayonet expulsion fuse accessible through primary compartment.

Current-limiting fuse accessible through tank handhole.

Expulsion Fuse for Low Current Faults: Interrupting capacity of 1,800 amperes rms asymmetrical.

Current Limiting for High Current Faults:

Interrupting capacity of 50,000 amperes rms symmetrical.

Bayonet fuse externally replaceable with hot stick.

Bayonet fuse links shall be dual sensing for both high currents and high oil temperature in order to provide thermal protection to the transformer.

Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse.

In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing, which closes when the fuse holder is removed and an external drip shield.

Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the OPEN position and the tank ressure has been released.

Bayonet Fuse Assembly: 150 kV BIL.

Oil-Immersed Current-Limiting Fuses: NEMA C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

Tank Grounding Pads

Low Voltage Compartment:

Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

Tap Changer Warning Sign

Red laminated plastic, engraved to white core.

Engrave to read DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

Mount above tap changer handle.

Adjustments

Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

Part 3 – Execution

General

Prepare subgrade for utility pad mounted transformer as specified in Section 02319, SUBGRADE PREPARATION, paragraph “Prepared Subgrade for Roadway, Embankment and Structures.”

Secure to mounting pads with anchor bolts.

Install plumb and longitudinally in alignment with pad or adjacent building wall.

Ground neutrals and enclosures in accordance with applicable codes and as shown on the Drawings.

Construction Quality Control

In accordance with Section 16080, ELECTRICAL TESTING.

END OF SECTION 16270-1

SECTION 16312 – OVERHEAD ELECTRICAL DISTRIBUTION SCHED. A

Part 1 – General

References

The following is a list of standards which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	National Electrical Safety Code
ANSI C12.7	Watthour Meter Sockets
ANSI C12.10	Watthour Meters
ANSI C12.11	Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV (0.6 kV NSV Through 69 kV NSV)
ANSI C12.13	Electronic Time-of-Use Registers for Electricity Meters
ANSI C12.15	Electricity Metering Solid-State Demand Registers for Electromechanical Watthour Meters
ANSI C12.16	Solid-State Electricity Meters
ANSI C29.2	Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	Wet-Process Porcelain Insulators, High-Voltage Pin Type
ANSI C29.7	Wet Process - Porcelain Insulators - High-Voltage Line-Post Type
ANSI C37.42	High Voltage Expulsion Type Distribution Class Fuses, Cutouts, Fuse Disconnecting Switches and Fuse Links
ANSI C57.12.20	Transformers – Overhead Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 34500 Volts and Below; Low-Voltage, 7970/13800Y Volts and Below
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment - Enclosure Integrity
ANSI O5.1	Wood Poles

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME D3487	Mineral Insulating Oil Used in Electrical Apparatus

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	Poles - Preservative Treatment by Pressure Processes
AWPA C25	Crossarms, Pressure Treatment

ASTM INTERNATIONAL (ASTM)

ASTM A53	Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
ASTM A153/A153M	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A475	Zinc-Coated Steel Wire Strand
ASTM B1	Hard-Drawn Copper Wire
ASTM B2	Medium-Hard-Drawn Copper Wire
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B228	Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B231/231M	Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B232/B232M	Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACSR)
ASTM B397	Concentric-Lay-Stranded Aluminum-Alloy 5005-H19 Conductors
ASTM B399/B399M	Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM D117	Electrical Insulating Oils of Petroleum Origin

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 48	Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765kV
IEEE C37.30	High-Voltage Switches
IEEE C37.60	Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems
IEEE C37.63	Overhead, Pad Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems
IEEE C57.12.00	General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.12.90	Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
IEEE C57.13	Instrument Transformers
IEEE C62.11	Metal-Oxide Surge Arrestors for Alternating Current Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 70	Standard for Non-shielded Power Cables Rated 2000V or Less for the Distribution of Electrical Energy

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	Electrical Power Distribution Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electrical Code

RURAL UTILITIES SERVICE (RUS)

RUS 202-1	List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers
RUS 1728F-700	Wood Poles, Stubs, and Anchor Logs
RUS 1728H-701	Wood Crossarms (Solid and Laminated Transmission Timbers and Pole Keys)

UNDERWRITERS LABORATORIES INC. (UL)

UL 6	Rigid Metal Conduit
UL 510	Polyvinyl Chloride Polyethylene and Rubber Insulating Tape

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

- Conductors.
- Insulators.
- Wood poles and crossarms.
- Utility vault (reference Section 16005, ELECTRICAL).
- Cutouts.
- Surge arrestors.
- Guy strand and guards.
- Anchors and anchor rods.
- Ground rods.

Conduit.

Submittals–Approval Not Required:

Information/Record (IR):

Test Reports:

Acceptance checks and tests.

Ground resistance test reports.

Certificates:

Wood poles.

Wood crossarms.

Delivery, Storage, And Handling

Pole Line Material Storage:

Poles that will be stored longer than 2 weeks shall be stored on supports at least 1 foot aboveground in accordance with ANSI O5.1. Strength and spacing of supports, and manner of stacking shall produce no noticeable distortion in poles.

Construction hooks, tongs, or other sharp tools shall not be used on the treated portion of poles. Do not use pointed tools capable of producing indentations of more than 1 inch in depth. Nails and holes are not permitted in the top of poles.

Cable Inspection: Upon delivery to construction site, cable and reels shall be inspected for shipping damage such as:

Marks caused by improper lifting equipment or techniques.

Breaks or cuts in outer covering.

Damaged jacket or insulation.

Reel damage from mishandling.

Cable Testing: Upon delivery to construction site and prior to installation, Construction General Contractor shall perform DC over-potential tests on new cable.

Cable Reel Storage:

Reels shall be stored with flanges resting on hard surface or pallets to prevent sinking into the ground.

Reel flanges shall not touch cable on other reels.

Reels shall not be stored on their sides; they shall be stored with reel axis horizontal.

Cable ends shall be taped or capped to prevent entrance of moisture.

Material stored at construction site shall be located to prevent damage from weather and adjacent construction operations.

Cable Reel Handling:

Slings and forklifts shall not contact cable or protective covering.

A spreader bar shall be used when lifting reel with bar and sling.

Reels shall not be dropped.

Part 2 – Products

Material And Equipment

Consider materials specified herein or shown on Drawings which are identical to materials listed in RUS 202-1 as conforming to requirements.

Wood Pole

Machine trimmed by turning western red cedar, cut from live timber in accordance with ANSI O5.1.

Poles shall be butt-treated by manufacturer in accordance with AWPA C7, using AWPA P8 and P9 preservatives.

Each pole shall be given single top cut at 30-degree angle with normal to axis of pole and at right angles to sweep. Gains shall be cut so roof will be at right angles to line and sweep of pole will be in line. Roofs and gains shall be brush-treated by manufacturer with specified preservative. Each gain shall fit crossarm tightly. Boltholes shall not be more than 1/16 inch oversize.

Quality of each pole shall be ensured with “WQC” (wood quality control) brand on each piece, or by an approved inspection agency report.

Wood Crossarm

Conform to RUS 1728H-701. Straight-gained Douglas fir, free from twists to within 0.1 inch per foot length, with bends and twists in one direction.

Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenite (ACA).

Treatment shall conform to AWPA C25.

Crossarm Braces: Provide wood crossarm braces as indicated.

Hardware

Hot-dip galvanized, conforming to ASTM A153/A153M.

Insulator

Provide wet-process porcelain insulators, which are radio interference free.

Line Post Type Insulators: ANSI C29.7, Class 4.

Suspension Insulators: ANSI C29.2, Quantity one per cable connection assembly, Class 4.

Spool Insulators: ANSI C29.3, Class 53-2.

Guy Strain Insulators: Porcelain, ANSI C29.4, Class 4, except provide fiberglass type when used with underground terminal or when other interference problems exist.

Pin Insulators: ANSI C29.5, Class 55-5.

Overhead Conductor

Conductor of bare copper, ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, ASTM B8, stranded, aluminum conductor steel reinforced (ACSR), ASTM B232/B232M, of size and type indicated.

Guys

Guy Strands: ASTM A475, extra-high strength, Class A or B, galvanized strand steel cable. Guy strand shall be 3/8 inch in diameter with ultimate breaking strength as shown on the Drawings. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

Round Guy Guard: Vinyl or PVC material, yellow colored, 8-feet long, and shatter resistant at sub-zero temperatures.

Guy Attachment: Thimble eye.

Anchor And Anchor Rod

Anchor shall be concrete cone anchor presenting holding area indicated on Drawings as a minimum. Anchor rod shall be twin thimble-eye, 3/4-inch diameter by 9-feet long. Anchor and anchor rod shall be hot-dip galvanized.

Grounding

Rod:

- Copper clad steel at least 3/4 inch in diameter and 10 feet long.
- Hard, clean, smooth, continuous, surface throughout length of rod.
- Die-stamp each near top with name or trademark of manufacturer and length of rod in feet.

Wire:

- Soft drawn copper wire ground conductor, minimum No. 4 AWG.
- Ground wire protector may be either PVC or half round wood molding. Wood molding shall be fir, pressure treated in accordance with AWPA C25, or shall be cypress or cedar.

Surge Arrestor

IEEE C62.11, metal oxide, polymer housing, surge arrestor arranged for equipment mounting. RMS voltage rating shall be 18 kV. Arrestor shall be Heavy-Duty Distribution class.

Fused Cutout

Nonloadbreak open type construction rated 100 amperes, 15 kV, 110 kV BIL, with a minimum 10,000 amperes symmetrical interrupting rating conforming to ANSI C37.42.

Fuses shall be of “6T” Link type, size as specified by Fluor Hanford Electric Utility (FHEU). Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

Conduit Riser And Conductor

Rigid galvanized steel conduit conforming to UL 6. Provide conductors (600 volts and above) as specified in Section 16120, CONDUCTORS.

Porcelain Insulator Type Terminator:

Comply with requirements of IEEE 48, Class 1, except that requirements of design tightness test need not be met.

Shall not exude any insulating filler compound under either test or service.

Consist of porcelain insulator, copper cable connector-hoodnut assembly and copper aerial lug as required, metal body and supporting bracket, sealed cable entrance, internal stress relief device for shielded cable, and insulating filler compound or material.

Electrical Tapes

Tapes shall be UL listed for electrical insulation and other purposes in wire and cable splices. Termination, repair, and miscellaneous purpose electrical tapes shall comply with UL 510.

Caulking Compound

Compound for Sealing Conduit Risers:

Puttylike consistency, workable with hands at temperatures as low as 35 degrees F.

Shall not slump at 300 degrees F and shall not harden materially when exposed to air.

Shall readily caulk or adhere to clean surfaces of material with which it is designed to be used.

Shall have no injurious effects upon workmen or upon materials.

Part 3 – Execution

Installation

General: Provide overhead pole line installation conforming to requirements of ANSI C2 for Grade C construction of overhead lines in medium loading districts and NFPA 70 for overhead services. Consider street, alleys, roads and drives “public.” Pole configuration shall be as indicated on Drawings.

Pole Setting: Provide pole holes at least as large at top as at bottom and large enough to provide 4 inch clearance between pole and side of hole.

Pole Setting Depths:

Length of Pole (feet)	Setting in Soil (feet)	Setting in Solid Rock (feet)
20	5.0	3.0
25	5.5	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0

Setting in Soil, Sand, and Gravel: Applying where the following occurs:

Where pole holes are in soil, sand, or gravel or any combination of these.

Where soil layer over solid rock is more than 2 feet deep.

Where hole in solid rock is not substantially vertical.

Where diameter of hole at surface of rock exceeds twice the diameter of pole at same level. At corners, dead ends, and other points of extra strain, poles 40 feet or more long shall be set 6 inches deeper.

Backfill: Thoroughly tamp pole backfill for full depth of hole and mound excess fill around pole.

Setting Poles: Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

Alignment of Poles: Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against strain. Set not less than 2 inches for each 10 feet of pole length above grade, nor more than 4 inches for each 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 5 feet in height. When ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid highest and lowest ground points. If it becomes necessary to shorten pole, a piece shall be sawed off top and shall be treated and capped. Holes shall be dug large enough to permit proper use of tampers to full depth of hole.

Pole Cap: Provide plastic pole caps with 1/4-inch sealing rings and 4 nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement, or an acceptable preservative paste to level of sealing ring to eliminate possibility of condensation. Place on pole top and nail each tab down with 1-1/4-inch nail. Pole caps are not necessary for ACA/CCA treated poles, unless they are shortened.

Cutting of Wood Poles: Where new gains or holes are required, paint gains with preservative compound as recommended by the pole manufacturer. Plug unused or abandoned holes using treated wood dowel pins.

Do not cut the tops of wood poles, except under very exceptional conditions, and only upon approval of Construction Manager. If cutting is deemed necessary, pole top shall be capped. Do not cut butt of wood poles.

Anchor and Guy: Place anchor in line with strain. Length of guy lead (distance from base of pole to top of anchor rod) shall be as indicated.

Setting Anchor: Set anchor in-place with anchor rod aligned with, and pointing directly at, guy attachment on pole with anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.

Setting Guy Strand:

Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section.

Provide strain insulator at a point on guy strand 8 feet, minimum, from ground and 6 feet, minimum, from surface of pole.

Hardware: Provide hardware with washer against wood and with nut and lock nut applied wrench tight. Provide locknut on threaded hardware connection. Locknut shall be M-F style and not palnut style.

Grounding: Conform to ANSI C2. Ground fused switches and lightning arrestors. Bond together pole line hardware separated by less than 2 inches.

Ground Rod Connection:

On pole lines by exothermic weld or by using compression connector for ground wire or wire to rod connection.

Exothermic welds strictly in accordance with manufacturer's written recommendations.

Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable.

No mechanical connectors are required at exothermic weldments.

Compression connector shall be type that uses hydraulic compression tool to provide correct pressure.

Provide tools and dies recommended by compression connector manufacturer.

Embossing die code or similar method shall provide visible indication that connector has been fully compressed on ground wire.

Grounding and Grounded Connections:

Where no primary or common neutral exists, surge arrestors and frames of equipment operating at over 750 volts shall be bonded together and connected to a dedicated grounding electrode.

Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts shall be bonded together and connected to a dedicated grounding electrode.

When a primary or common neutral exists, connect all grounding and grounded conductors to common grounding electrode.

Protective Molding: Protect grounding conductors that are run on surface of wood poles by wood molding or plastic molding of equal mechanical strength extending from ground line throughout communication and transformer spaces.

Conductors: Prevent nicking, kinking, gouging, flattening, or otherwise deforming or weakening conductor or impairing its conductivity. Remove damaged sections of conductor and splice conductor.

Splices: Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 10 feet of a support.

Ties: Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

Reinstalling: Existing conductors to be reinstalled or resagged shall be strung to "final" sag table values indicated for particular conductor type and size involved.

New Installation: String new conductors to "initial" sag table values indicated for conductor type and size of conductor and ruling span indicated.

Aluminum Protection: Protect ACSR conductors by armor rod at pin insulators and by flat aluminum wire at attachments made of galvanized or coated iron or steel.

Fittings: Dead end fittings, clamp or compression type, shall conform to written recommendations of conductor manufacturer and shall develop full ultimate strength of conductor.

Aluminum Connections: To copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose.

Riser: Secure conduit on pole by two hole galvanized steel pipe straps spaced no more than 10 feet apart and within 3 feet of any outlet or termination. Ground metallic conduit.

Construction Quality Control

Wood Crossarm Inspection: Furnish inspection report from independent inspection agency, approved by the Tank Farm Contractor, stating that offered products comply with applicable AWPA and RUS standards. The RUS approved Quality Mark "WQC" on each crossarm will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

Acceptance Checks and Tests:

Notify Fluor Hanford Electrical Utility (FHEU) 5 working days prior to start of checking and testing. FHEU will test 15 kV cables and transformers.

Perform in accordance with manufacturer's recommendations and include the following visual and mechanical inspections, and electrical tests, performed in accordance with NETA ATS.

Grounding System:

Visual and Mechanical Inspection: Inspect ground system for compliance with Drawings and Specifications.

Electrical Tests: Perform ground-impedance measurements utilizing fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of single ground rod, perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. Instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate ground value of ground rod or grounding systems under test.

Report: Before energizing electrical equipment, submit the measured ground resistance of grounding system.

Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at time measurements were made.

Devices Subject to Manual Operation: Operate at least three times, demonstrating satisfactory operation each time.

Follow-Up Verification: Upon completion of acceptance checks and tests, show, by demonstration in service, that circuits and devices are in operating condition and properly performing intended function.

END OF SECTION 16312

SECTION 16440 – LOW VOLTAGE MOTOR CONTROL SCHED. B

Part 1 – General

UL Compliance

Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark.

Approval By Authority Having Jurisdiction (AHJ)

As specified in Section 16005, ELECTRICAL.

Electrical Description of Work

Provide the following 480-volt, three-phase, four-wire with ground, 600-amp service rated motor control centers in accordance with this Specification and Contract Drawings:

- 219A-LH-MCC-001 to be installed inside the Cell No. 1 Crest Pad Building 219A.
- 219E-LH-MCC-001 to be installed inside the Cell No. 2 Crest Pad Building 219E.
- MCC(s) shall be provided with the following minimum features in accordance with this Specification and Contract Drawings:
- Main Incoming Service Breaker, with service neutral terminal connection in main breaker section only.
- Portable Generator Power Outlet Feeder Breaker and Kirk Key (ed) arrangement with main incoming service breaker.
- Phase Loss and Reversal Protection Relay and Alarm Lighting.
- Transient Voltage Surge Suppressor (TVSS).
- Volt and Current Meters and Selector Switches.
- Lighting Panel.
- Lighting Panel Transformer.
- NEMA 1 Size Motor Starters (incorporating: breaker, control power transformer, fuses, contactor, overloads, indicators, control switches, elapsed time meter, terminal strips, wiring, and locking mechanism).
- NEMA Feeder Breakers.
- Three Sections.
- Time Delay and Magnetic Control Relays.
- Interlocking control relays, terminals, and lining assembled together in unit compartment.

Submittals–Approval Required

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

- Itemized bill-of-material.
- Descriptive information.

Dimensional drawings.

Conduit entrance locations.

Bus data.

Protective Devices:

Copies of time-current characteristics.

Operational description.

Anchoring instructions and details.

Typed Tabulation:

Motor name; tag (equipment) numbers as shown on Drawings.

Motor horsepower.

Nameplate full load current.

Measured load current and voltage.

Heater catalog number.

Protective device trip settings.

Attach above typed, tabulated data to a copy of starter manufacturer's overload selection tables for the starters provided.

Control Diagrams:

NEMA ICS 2, Section 322.08 Type I.

Wiring Type B.

In addition to standard NEMA control diagrams, provide the following:

Remote control devices.

Remote indication and/or pilot lights.

Interconnections and interlocking circuits between starter and remote equipment.

Remote sensors.

Tag numbers associated with all control devices and equipment.

One-line diagrams.

Schematic (elementary) diagrams.

Outline diagrams.

Submittals–Approval Not Required

Information/Record (IR):

Manufacturer's installation instructions.

Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Submit documentation and test results for construction quality control testing.

Packing And Shipping:

Shipping Splits: Established by Construction Subcontractor to facilitate ingress of equipment to final installation location within the building.

Part 2 – Products (Reference Section 16005, Electrical)

Manufacturers

Square D.

Cutler-Hammer.

General Electric.

Allen-Bradley.

Motor Control

General:

Like Items of Equipment: End product and responsibility of one manufacturer.

Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

Controllers: NEMA ICS 2, Class B.

Electronic Overload Protection:

Programmable solid-state electronic overload relay with integral CT(s) for monitoring three-phase current and voltage, thereby providing motor overload, phase reversal and phase loss protection. In the event of an alarm condition, electronic overload relay will de-energize fail safe alarm contact to motor control circuit.

Ratings:

Voltage Range (L1, L2-L3): 480 volts 50/60 Hz.

Current Range: Specific range compatible with motor FLA operation.

Power Consumption: 10 watts.

Trip Circuit: Form C SPDT (N.O and N.C) contacts, 5 amps 120 volts.

Measurements: Voltage, current, and timing.

Relay Trip: Standard Class 20.

Manual Reset.

Mount within starter unit.

Manufacturer:

Square D.

Allen-Bradley.

General Electric.

Cutler-Hammer.

Control Transformer:

Two winding, 120-volt secondary, primary voltage to suit.

Two current-limiting fuses for primary circuit.

One fuse in secondary circuit.

Mount within starter unit.

Suitable for use with 75 degrees C copper wire at full NFPA 70, 75 degrees C ampacity.

Lifting lugs on all equipment and devices weighing over 100 pounds.

Operating Conditions:

Ambient Temperature: Maximum 40 degrees C.

Equipment to be fully rated without any derating for operating conditions listed in Section 16005, ELECTRICAL.

Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.

Equipment Finish:

Electrocoating process applied over a rust-inhibiting phosphated base coating.

Exterior Color: Manufacturer's standard.

Manually Operated Starter, Fractional Horsepower:

Rating: 16 amperes continuous at 277 volts maximum, or horsepower rated for the voltage and horsepower of the load served.

Single-phase, nonreversing, full voltage with overload protection.

Toggle operated.

Enclosure: Reference Section 16005, ELECTRICAL, Article ENVIRONMENTAL CONDITIONS.

Pilot LED Light: Red.

Handle guard/lock-off attachment.

Combination Full-Voltage, Magnetic Starter:

Rating: Hp rated at 600 volts, UL labeled for 42,000 amperes fault current withstand capacity with overload protection.

Three-phase, nonreversing, full voltage.

Control: HAND/OFF/AUTO selector switch.

Disconnect Type: Motor circuit protector.

Enclosure: Reference Section 16005, ELECTRICAL, Article ENVIRONMENTAL CONDITIONS.

Pilot LED Lights: Red—ON and Green—OFF.

Padlockable operating handle.

Kirk Key Interlocks

Provide Kirk Key interlocks for one main and one portable generator plug breaker arrangement in each MCC.

Provide engraved plate on MCC which describes Kirk Key breaker arrangement and operation as described herein.

Operation:

- One unique key available for MCC main and portable generator breaker locks (i.e., Kirk keys for additional MCC(s) shall not be identical).
- One of the two breakers CLOSED at any one time.
- Breaker must be opened before key can be removed and inserted.
- Key must be inserted and operated before breaker can be CLOSED.

Motor Control Centers

General:

Motor Control Center to be manufactured and provided as a complete UL-approved assembly that includes the following major components specified under this section and Section 16005, ELECTRICAL:

- Motor starters with electronic overload protection relays.
- Feeder and main breakers.
- Power monitoring.
- Lighting and power distribution panelboard.
- Lighting and power distribution stepdown transformer.
- Transient Voltage Surge Suppressor (TVSS).
- Interlocking control relays.
- In accordance with NEMA ICS 2, UL 845, and UL 508/508A.

Voltage Rating: 600 volts.

Short Circuit Rating: 42,000 minimum amperes rms symmetrical for entire motor control center as a complete assembly.

All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.

NEMA ICS 2, Section 322.08.

Class: I.

Type: B.

Wire remote control and signal circuits to separate terminal board in each motor starter compartment.

Enclosure:

Type: NEMA 250 Type 12 unless otherwise rated.

Vertical Section Dimensions: 90 inches high, 20 inches wide, 20 inches deep.

Construction:

- Sheet steel reinforced with channel or angle irons.
- Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
- Removable top cover plates and bottom cover plates.

Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.

Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.

Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.

Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.

Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.

External disconnect handles, padlockable in OFF position.

Cable Entrance: Incoming service enters from bottom; control and feeder circuits enter from top and bottom.

Bus:

Horizontal Power Bus:

- Three-phase tin-plated, fully insulated, copper, entire width of control center, rated 600 amperes.
- Construct to allow future extension of additional sections.
- Pressure type solderless lugs for each incoming line cable.
- Isolated from top horizontal wireway.

Provide Belleville washers on bus connection bolts.

Vertical Power Bus:

Three-phase tin-plated, fully insulated, copper, full height of section, rated 300 amperes.

Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.

Insulated and isolated barrier complete with shutters.

Provide Belleville washers on bus connection bolts.

Neutral Bus: 50 percent neutral, copper-tin-plated main breaker section only.

Ground Bus:

Copper, tin-plated, 33 percent minimum of phase bus ampacity, entire width of control center.

Provide Belleville washers on bus connection bolts.

Bus Bracing: 42,000 minimum amperes rms symmetrical.

Motor Controller Unit:

Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in this section.

Construction:

Drawout combination type with stab connections for starters NEMA ICS, Size 4 and smaller.

Readily interchangeable with starters of similar size.

Pull-apart unit control wiring terminal boards on all units.

Starters: NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.

Rating: Hp rated at 600 volts, UL labeled for 42,000 amperes fault current withstand capacity with overload protection.

Three-phase, nonreversing.

Disconnect Type: Thermal magnetic as shown. Motor circuit protector may be substituted, properly sized and adjusted.

Combination Full Voltage, Magnetic Starter:

Control: ON/OFF/AUTO selector switch. As shown.

Pilot LED Lights: Red—ON; Green—OFF.

Padlockable operating handle when de-energized.

Unit door interlocked to prevent opening when disconnect is in closed position.

Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

Disconnecting Device: In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.

Padlockable in OPEN position.

Circuit Breaker:

Meeting the requirements of NEMA AB1 and UL 489.
Molded case with manufacturer's recommended trip setting for maximum motor protection.
Thermal-magnetic trip or magnetic trip only as shown.
Tripping indicated by operating-handle position.
Interrupting capacity required for connection to system with short circuit capacity indicated.

Motor Overload, Phase Reversal and Loss Protection:

Programmable solid-state electronic overload relay with internal CTs for monitoring three-phase current and voltage, thereby providing motor overload, phase reversal, and phase loss protection.

Make overload adjustments based upon motor FLA.

Make voltage adjustments based upon incoming voltage nominal readings.

Control Unit:

Disconnecting Device: Capable of de-energizing external source control circuits in unit.

Control Devices: As indicated and as specified in Section 16005, ELECTRICAL.

Control Wiring:

Minimum wire size No. 14 AWG copper.
Permanent sleeve type markers with wire numbers applied to each end of wires.
Terminate current transformer leads on shorting type terminal blocks.

Feeder Unit and Main Protective Device:

Construction: As specified in paragraph Motor Controller Unit.

Incoming Service Feeder: Cable entering section at bottom.

Molded Case Circuit Breaker:

In accordance with NEMA AB1 and UL 489.
Main, feeder, and motor protective device.
UL labeled as suitable for service entrance.
Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.

Indicate tripping by operating-handle position.
Suitable for use with 75 degrees C copper wire at full NEC 75 degrees C ampacity.

Reset Timer:

Timing Method: Solid state with LCD display.

Mounting: Semi-flush, panel.

Contacts: 5-amp, 120-volt.

Manufacturers and Products:

Square D.
Cutler-Hammer.
General Electric.

Magnetic Contactor:
UL listed.
Electrically operated, electrically held.

Main Contacts:
NEMA B600 contacts.
Electrically held.
Silver alloy with wiping action and arc quenchers.
NEMA Size 0 or 1 as required for the motor controller.
Three-pole.

Control: Two-wire.
One normally open and one normally closed auxiliary contact rated 10 amperes at 480 volts.

Manufacturers and Products:
Allen-Bradley.
Square D Co.; Type F.
Cutler-Hammer.

Pushbutton, Indicating Light and Selector Switches:

Contact Rating: NEMA ICS 2, Type A600.

Selector Switch Operating Lever: Standard.

Indicating Lights: Push-to-test, LED, full voltage.

Pushbutton Color:

ON or START: Black.

OFF or STOP: Red.

Pushbuttons and selector switches lockable in OFF position where indicated.

Legend Plate:

Material: Aluminum.

Engraving: 11 characters/spaces on one line, 14 characters/spaces on each of two lines, as required, indicating specific function.

Letter Height: 7/64 inch.

Manufacturers:

- Square D Co.
- Cutler-Hammer.
- General Electric.
- Allen-Bradley.

Nameplates:

- Provide nameplates per Hanford standards.
- Laminated plastic; white, engraved to black core.
- Provide for each motor control center and each unit.
- Engrave with inscription shown on single-line diagram.
- Provide blank nameplates on spaces for future units.
- Attach with stainless steel panhead screws on face of control center.

Factory Testing: NEMA ICS 1, Section 109, or UL 486A if not specified by the manufacturer.

Part 3 – Execution

Installation

Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions. Reference Section 13122, METAL BUILDING SYSTEMS, Part 2, Article DESIGN LOADS, for information on seismic loading. Install suitable braces from MCC to building structural members for seismic support.

Install equipment plumb and in longitudinal alignment with pad or wall.

Coordinate terminal connections with installation of secondary feeders.

Grout mounting channels into floor or mounting pads.

Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

Circuit Breakers (Magnetic-Trip-Only)

Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

Adjust to approximately 11 times motor rated current in accordance with NEC 430-52.

Determine motor rated current from motor nameplate following installation.

Overload Relay

Select and install overload relay settings after the actual nameplate full-load current rating of motor has been determined.

Motor Data

Provide typed, self-adhesive label attached outside each motor starter enclosure door displaying the following information with plastic black and white lettering, minimum 1/2-inch size:

- Motor served by tag number and equipment name.
- Nameplate horsepower.
- Motor code letter.
- Full load amperes.
- Service factor.
- Installed overload relay heater catalog number.

Construction Quality Control

In accordance with Section 16080, ELECTRICAL TESTING.

Manufacturer's Services

Furnish manufacturer's representative in accordance with Section 01640, MANUFACTURERS' SERVICES, for the following services at jobsite for minimum person-days listed below, travel time excluded:

- Person-day for installation assistance, and inspection of installation.
- Person-day for functional and performance testing.

END OF SECTION 16440

Appendix C9

Integrated Disposal Facility (IDF) Infrastructure Construction Specification

CHPRC-03953

Revision 0

Project Title: Integrated Disposal Facility Infrastructure Design

Status: ☐ In-Process ☒ Final

Contains assumptions and/or inputs that require verification: ☐ Yes ☒ No

Specification History

Revision	Revision Summary	Approvals/Date	
0	Initial Release per DCN-IDF-006	Architectural:	Michael Corbin, AIA /9/9/2019
		Electrical:	Daniel Mendoza, PE /9/9/2019
		I&C:	David King, PE /9/9/2019
		Civil:	Dick Nelson, PE /9/9/2019
		Structural:	Cody Cox, PE /9/9/2019
		Mechanical:	Anthony Frost, PE /9/9/2019
		HVAC:	Milo Himes, PE /9/9/2019
		Architectural Checker:	Renata Presby, AIA 9/10/2019
		Electrical Checker:	David King, PE /9/9/2019
		I&C Checker:	Daniel Mendoza, PE /9/9/2019
		Civil Checker:	Cody Cox, PE /9/9/2019
		Structural Checker:	Dick Nelson, PE /9/9/2019
		Mechanical Checker:	Teresa Torres, PE /9/9/2019
		HVAC Checker:	Scott Anderson, PE 9/9/2019
		Approver:	Richard Sexton /9/10/2019

Contents

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[2]Electrical
[3]I&C
[4]Civil
[5]Structural
[6]Mechanical
[7]HVAC

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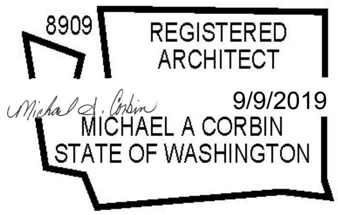

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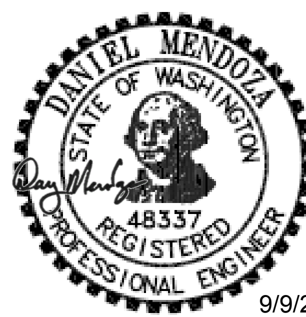

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SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition and removal of selected site elements.
   2. Salvage of existing items to be reused or recycled.

B. Related Requirements:
   1. Section 01 10 00 "Summary" for restrictions on use of the premises, and phasing requirements.
   2. Section 31 10 00 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective demolition.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them as required and defined by CHPRC/DOE.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste is property of DOE.

1.4 PREINSTALLATION MEETINGS

A. Pre-demolition Conference: Conduct conference at Contracting Office.
   1. Inspect and discuss condition of construction to be selectively demolished.
   2. Review structural load limitations of existing structure.
   3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
   5. Review areas where existing construction is to remain and requires protection.

1.5 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's managers on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.

3. Coordination for shutoff, capping, and continuation of utility services.
4. Coordination of Owner's continuing occupancy of portions of existing buildings and facilities.

C. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 "Photographic Documentation." Submit before Work begins.

D. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

A. To meet CHPRC/DOE requirements

1.8 FIELD CONDITIONS

A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
   1. Before selective demolition, Owner will remove the following items:
      a. Non-fixed appurtenances

B. Notify CHPRC of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
   1. Hazardous material remediation is specified elsewhere in the Contract Documents and is specific to DOE requirements.
   2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
   3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

D. Storage or sale of removed items or materials on-site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing DOE/EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Verify that hazardous materials have been remediated before proceeding with demolition operations.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.

1. Comply with requirements specified in Section 01 32 33 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 PREPARATION

A. Meet DOE/CHPRC requirements for preparation

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
   a. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   b. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   c. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of buildings or areas.
2. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 50 00 "Temporary Facilities and Controls."

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose per contract requirements.
2. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting elements.
3. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Contracting Officer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an DOE/EPA-approved construction and demolition waste landfill acceptable to Hanford authorities having jurisdiction. And recycle or dispose of them according to Section 01 74 19 "Construction Waste Management and Disposal."

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 01 74 19 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 03 10 00 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 03 33 00 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 03 35 43 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 03 53 00 "Concrete Topping" for emery- and iron-aggregate concrete floor toppings.
6. Section 31 20 00 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 32 13 13 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.
   e. Special concrete finish Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold and hot weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement
7. Aggregates.
8. Admixtures:

   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

9. Vapor retarders.
10. Floor and slab treatments.
11. Liquid floor treatments.
12. Curing materials.

    a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.

13. Joint fillers.
14. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Calculated equilibrium unit weight, for lightweight concrete.
6. Slump limit.
7. Air content.
8. Nominal maximum aggregate size.

9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
11. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
12. Intended placement method.
13. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

   a. Location of construction joints is subject to approval of the Architect.

D. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semirigid joint filler.
9. Joint-filler strips.
10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Silica fume.
6. Performance-based hydraulic cement.
7. Aggregates.

8. Admixtures:

   a. Permeability-Reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

   1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
   2. For sheet vapor retarder/termite barrier, showing compliance with ICC AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician with experience installing and finishing concrete, incorporating permeability-reducing admixtures.

   1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

   1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

   1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

   1. Personnel conducting field tests shall be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

   1. Include the following information in each test report:

      a. Admixture dosage rates.

b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Permeability.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.10 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
2. Obtain aggregate from single source.
3. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I, white.
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.
5. Silica Fume: ASTM C1240 amorphous silica.
6. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: Type GU, general use.

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:

   a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
   b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
   c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.

2. Maximum Coarse-Aggregate Size: 1 inch nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
7. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) BASF Corporation.
      2) Euclid Chemical Company (The); an RPM company.
      3) Sika Corporation.

8. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) BASF Corporation.
2) Cortec Corporation.
3) Sika Corporation.

9. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AQUAFIN, Inc.
2) Kryton International Inc.

b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRC C48 at a hydraulic pressure of 200 psi for 14 days.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable or complying with ASTM C1602/C1602M, including all limits listed in Table 2 and the requirements of paragraph 5.4

2.3 VAPOR RETARDERS

A. Bituminous Vapor Retarder: ASTM E1993/E1993M, 110-mil-thick, semiflexible, seven-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.

1. Water-Vapor Permeance: 0.0011 grains/h x sq. ft. x inches Hg when tested in accordance with ASTM E154/E154M.
2. Tensile Strength: 156 lbf/inch when tested in accordance with ASTM E154/E154M.
3. Puncture Resistance: 140 lbf when tested in accordance with ASTM E154/E154M.

2.4 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 4 sieve.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

2.5 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F: Black.
b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
c. Ambient Temperature Above 85 deg F: White.

D. Curing Paper: Eight-feet-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable or complying with ASTM C1602/C1602M.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.7 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.8 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand, as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested in accordance with ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.

3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

   1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

   1. Fly Ash or Other Pozzolans: 25 percent by mass.
   2. Slag Cement: 50 percent by mass.
   3. Silica Fume: 10 percent by mass.
   4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
   5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

   1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs.
   4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
   5. Use permeability-reducing admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.10 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

   1. Exposure Class: ACI 318 F2.
   2. Minimum Compressive Strength: 3000 psi at 28 days.
   3. Maximum w/cm: 0.50.
   4. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
   5. Slump Flow Limit: 22 inches, plus or minus 1.5 inches.
   6. Air Content:
      a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 1-inch nominal maximum aggregate size.

   7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 F2.
2. Minimum Compressive Strength: 3500 psi at 28 days.
3. Maximum w/cm: 0.50.
4. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture at Project site.
5. Slump Flow Limit: 22 inches, plus or minus 1.5 inches.
6. Air Content:
   a. Exposure Classes F2 and F3: 6 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/C1116M, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure facilities for storage, initial curing, and field curing of test samples, including continuous electrical power.
4. Security and protection for samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDER

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
2. Face laps away from exposed direction of concrete pour.
3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
4. Lap joints 6 inches and seal with manufacturer's recommended tape.
5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.
6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.

   a. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

   a. Continue reinforcement across construction joints unless otherwise indicated.
   b. Do not continue reinforcement through sides of strip placements of floors and slabs.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

F. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

1. If a section cannot be placed continuously, provide construction joints as indicated.
2. Deposit concrete to avoid segregation.

3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

   a. Do not use vibrators to transport concrete inside forms.
   b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
   c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
   d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.7 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated on Drawings. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.

1. Coordinate required final finish with Architect before application.
2. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

D. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish to concrete stair treads, platforms, ramps as indicated on Drawings

1. Apply in accordance with manufacturer's written instructions and as follows:

   a. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications.
   b. Tamp aggregate flush with surface, but do not force below surface.
   c. After broadcasting and tamping, apply float finish.
   d. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

E. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces in accordance with manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating.
3. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
4. After final floating, apply a trowel finish.
5. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.9 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply in accordance with manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

D. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Floors:

a. Floors to Receive Curing Compound:

1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Maintain continuity of coating, and repair damage during curing period.
4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

b. Floors to Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.10 TOLERANCES

A. Conform to ACI 117.

3.11 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 14 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month(s).
2. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

    a. Limit cut depth to 3/4 inch.
    b. Make edges of cuts perpendicular to concrete surface.
    c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    d. Fill and compact with patching mortar before bonding agent has dried.
    e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

    a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    b. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
2. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

1) Project name.
2) Name of testing agency.
3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
4) Name of concrete manufacturer.
5) Date and time of inspection, sampling, and field testing.
6) Date and time of concrete placement.
7) Location in Work of concrete represented by samples.
8) Date and time sample was obtained.
9) Truck and batch ticket numbers.
10) Design compressive strength at 28 days.
11) Concrete mixture designation, proportions, and materials.
12) Field test results.
13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
14) Type of fracture and compressive break strengths at seven days and 28 days.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

   a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests when concrete consistency appears to change.

3. Slump Flow: ASTM C1611/C1611M:

a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
b. Perform additional tests when concrete consistency appears to change.

4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete;.

a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:

a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.

6. Compression Test Specimens: ASTM C31/C31M:

a. Cast and laboratory cure two sets of three 6-inch by 12-inch cylinder specimens for each composite sample.
b. Cast, initial cure, and field cure two sets of three standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M.

a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
b. Test one set of two field-cured specimens at seven days and one set of two specimens at 28 days.
c. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests:

a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.15 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using Floor Slab Protective Covering.

END OF SECTION 03 30 00

SECTION 03 30 53

MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 31 00 00 "Earthwork" for drainage fill under slabs-on-grade.
2. Section 32 16 13 "Concrete Sidewalks" for concrete pavement and walks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Design Mixtures: For each concrete mixture.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. Comply with the following sections of ACI 301 unless modified by requirements in the Contract Documents:

1. "General Requirements."
2. "Formwork and Formwork Accessories."
3. "Reinforcement and Reinforcement Supports."
4. "Concrete Mixtures."
5. "Handling, Placing, and Constructing."

B. Comply with ACI 117.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I Type II Type I/II Type III or Type V.

2. Fly Ash: ASTM C 618, Class C or F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag, Type IP, portland-pozzolan, Type IL, portland-limestone, Type IT, ternary blended, cement.

C. Normal-Weight Aggregate: ASTM C 33/C 33M, 1-1/2-inch nominal maximum aggregate size.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Water: ASTM C 94/C 94M.

2.4 RELATED MATERIALS

A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.

B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick; or plastic sheet, ASTM E 1745, Class C.

C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.5 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Clear, Waterborne or Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.6 CONCRETE MIXTURES

A. Comply with ACI 301.

B. Normal-Weight Concrete:

1. Minimum Compressive Strength: 4500 psi at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

4. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture], plus or minus 1 inch.
5. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116, and furnish batch ticket information.

1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.

1. Lap joints 6 inches and seal with manufacturers recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groove marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Comply with ACI 301 for placing concrete.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Do not add water to concrete during delivery, at Project site, or during placement.

D. Consolidate concrete with mechanical vibrating equipment according to ACI 301.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/2 inch.

1. Apply to concrete surfaces not exposed to public view.

3.8 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes unless otherwise indicated.

D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.

E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.

    b. Continuous water-fog spray.

    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Tests: Perform according to ACI 301.

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

END OF SECTION 03 30 53

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Prefabricated building columns.
3. Field-installed shear connectors.
4. Grout.

B. Related Requirements:

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.
2. Welded built-up members with plates thicker than 2 inches.
3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Contracting Office.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical, high-strength bolted connections.
5. Identify members and connections of the Seismic-Load-Resisting System.
6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

D. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer fabricator, shop-painting applicators, professional engineer, testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength, bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Non-shrink grout.

F. Survey of existing conditions.

G. Source quality-control reports.

H. Field quality-control and special inspection reports.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

B. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 minimum or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

D. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.

4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.

   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use Load and Resistance Factor Design; data are given at factored-load level.

B. Moment Connections: Type PR, partially or Type FR, fully restrained.

C. Construction: Moment frame, braced frame, Shear wall system, combined system of moment frame and braced frame or Combined system of moment frame and shear walls or Combined system of braced frame and shear walls or Combined system of moment frame, braced frame, and shear walls.

2.2 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 572/A 572M, Grade 50.

B. Channels, Angles, M , S-Shapes: ASTM A 572/A 572M, Grade 50.

C. Plate and Bar: ASTM A 572/A 572M, Grade 50.

D. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50.

E. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.

F. Corrosion-Resisting, Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.

G. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

H. Steel Forgings: ASTM A 668/A 668M.

I. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.

   1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.

   1. Finish: Hot-dip zinc coating, mechanically deposited zinc coating, Hot-dip or mechanically deposited zinc coating.
   2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating, mechanically deposited zinc coating, baked epoxy-coated finish.

D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

   1. Finish: Plain or mechanically deposited zinc coating.

E. Un-headed Anchor Rods: Grade 50 ASTM A 36/A 36M.

   1. Configuration: Straight or Hooked.
   2. Nuts: ASTM A 563.
   3. Plate Washers: ASTM A 36/A 36M carbon steel.
   4. Washers: ASTM F 436, Type 1, hardened carbon steel.
   5. Finish: Plain, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50].

F. Headed Anchor Rods: ASTM F 1554, Grade 36 or ASTM F 1554, Grade 55, weldable, straight.

   1. Nuts: ASTM A 563.
   2. Plate Washers: ASTM A 36/A 36M carbon steel.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.
   4. Finish: Plain or Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

G. Threaded Rods: ASTM A 572/A 572M, Grade 50.

   1. Nuts: ASTM A 563.
   2. Washers: ASTM F 436, Type 1, hardened or ASTM A 36/A 36M carbon steel.
   3. Finish: Plain or Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

H. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.4 PRIMER

A. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." Section 099600 "High-Performance Coatings.” Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Primer: SSPC-Paint 25, Type I or Type II, zinc oxide, alkyd, linseed oil primer.

C. Primer: SSPC-Paint 25 BCS, Type I or Type II, zinc oxide, alkyd, linseed oil primer.

D. Primer: SSPC-Paint 23, latex primer.

E. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

F. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 ASTM A 780/A 780M.

2.5 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

1. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
2. Mark and match-mark materials for field assembly.
3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning." SSPC-SP 2, "Hand Tool Cleaning. "SSPC-SP 3, "Power Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural-steel frame. Straighten as required to provide uniform, square, and true members in completed wall framing. Build up welded framing, weld exposed joints continuously, and grind smooth.

H. Welded Door Frames: Build up welded door frames attached to structural-steel frame. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, Pre-tensioned or Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 PREFABRICATED BUILDING COLUMNS

A. Prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell.

B. Fire-Resistance Ratings: Provide prefabricated building column listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.

1. Fire-Resistance Rating: As indicated.

2.9 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces of high-strength bolted, slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.
6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.10 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates, Bearing Plates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten, Pretension anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened, Pre-tensioned or Slip critical.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Contractor will engage a qualified special inspector to perform the following special inspections:

1. Verify structural-steel materials and inspect steel frame joint details.
2. Verify weld materials and inspect welds.
3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   a. Liquid Penetrant Inspection: ASTM E 165.
   b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   c. Ultrasonic Inspection: ASTM E 164.
   d. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.7 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

END OF SECTION 05 12 00

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof rafter framing.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 09 21 16.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 09 22 16 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated-Design Submittal: For cold-formed steel framing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.

E. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Framing Industry Association.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Roof Rafter Framing: Vertical deflection of 1/360 of the horizontally projected span for live loads.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

1. Floor and Roof Systems: AISI S210.
2. Headers: AISI S212.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent.

2.4 ROOF-RAFTER FRAMING

A. Steel Rafters: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.105 inch.
2. Flange Width: 3-1/2 inches, minimum.

2.5 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Gusset plates.
7. Hole-reinforcing plates.
8. Backer plates.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.

B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

2.7 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.

C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

    1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

    1. Cut framing members by sawing or shearing; do not torch cut.
    2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

        a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
        b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 07 21 00 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches.
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.

C. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement.

1. Install web stiffeners to transfer axial loads of walls above.

D. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Combination Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

E. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

F. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.5 ERECTION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00

METALFABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Prefabricated building columns.
5. Shelf angles.
6. Structural-steel door frames.
7. Miscellaneous steel trim including steel angle corner guards.
8. Metal bollards.
9. Abrasive metal nosings, treads and thresholds.
10. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 051200 "Structural Steel Framing."

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.

2. Prefabricated building columns.
3. Metal nosings and treads.
4. Paint products.
5. Grout.

B. Sustainable Design Submittals:

C. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Prefabricated building columns.
4. Shelf angles.
5. Structural-steel door frames.
6. Miscellaneous steel trim including steel angle corner guards.
7. Metal bollards.
8. Abrasive metal nosings, treads and thresholds.
9. Loose steel lintels.

D. Samples for Verification: For each type and finish of extruded nosing and tread.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders and alternating tread devices.

B. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft..
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

F. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

G. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

H. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

I. Zinc-Coated Steel Wire Rope: ASTM A 741.

1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches.
2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33; 0.0966-inch minimum thickness; hot-dip galvanized after fabrication.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
3. Provide stainless-steel fasteners for fastening nickel silver.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

G. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize and prime exterior steel frames.

D. Prime exterior steel frames with zinc-rich primer.

2.8 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime exterior miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with zinc-rich primer.

2.9 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

1. Cap bollards with 1/4-inch-thick steel plate.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel pipe or tubing with 1/4-inch-thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch steel machine bolt.

E. Prime bollards with zinc-rich primer.

2.10 ABRASIVE METAL NOSINGS TREADS AND THRESHOLDS

A. Cast-Metal Units: Cast iron, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Nosings: Cross-hatched units, 4 inches wide with 1-inch lip, for casting into concrete.
2. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches, for casting into concrete.
3. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
4. Thresholds: Fluted-saddle-type units, 5 inches wide by 1/2 inch high, with tapered edges.
5. Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches wide by 5/8 inch high, with tapered edge.
6. Thresholds: Plain-stepped- (stop-) type units, 5 inches wide by 1/2 inch high, with 1/2-inch step.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.

1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

D. Apply bituminous paint to concealed surfaces of cast-metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.11 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer.

2.12 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with universal shop primer unless zinc-rich primer is indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.

2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLING METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.5 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.6 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.7 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. AISC 303, “(2005) Code of Standard Practice for Steel Buildings and Bridges”
2. AWS D1.1/D1.1M, “(2008) Structural Welding Code - Steel ASME INTERNATIONAL (ASME)”
3. ASME B18.2.1, “(1996; Addenda A 1999; Errata 2003; R 2005 Square and Hex Bolts and Screws (Inch Series)”
4. ASME B18.2.2, “(1987; R 2005) Standard for Square and Hex Nuts”
5. ASME B18.22.1, “(1965; R 2008) Plain Washers ASTM INTERNATIONAL (ASTM)”
6. ASTM A 123/A 123M, “(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products”
7. ASTM A 153/A 153M, “(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware”
8. ASTM A 307, “(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength”
9. ASTM A 36/A 36M, “(2008) Standard Specification for Carbon Structural Steel”
10. ASTM A 47/A 47M, “(1999; R 2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process”
11. ASTM A 500/A 500M, “(2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes”
12. ASTM A 53/A 53M, “(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless”
13. ASTM A 653/A 653M, “(2008) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”
14. ASTM A 687, “(1993) Standard Specification for High-Strength Nonheaded Steel Bolts and Studs”
15. ASTM A 780, “(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings”
16. ASTM A 786/A 786M, “(2005) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates”
17. ASTM A 924/A 924M, “(2008) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process”
18. SSPC SP 3, “(2004; E 2004) Power Tool Cleaning”
19. SSPC SP 6, “(7) Commercial Blast Cleaning”

1.2 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-02 Shop Drawings

   a. Guard posts (bollards/pipe guards); G

   b. Embedded angles and plates, installation drawings; G

2. SD-03 Product Data

   a. Metal Fabrications; G;

1.3 QUALIFICATION OF WELDERS

A. Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

1.4 DELIVERY, STORAGE, AND PROTECTION

A. Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Carbon Steel: ASTM A 36/A 36M.

B. Structural Tubing: ASTM A 500/A 500M.

C. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

D. Fittings for Steel Pipe: Standard malleable iron fittings ASTM A 47/A 47M.

E. Anchor Bolts: ASTM A 307. Where exposed, shall be of the same material, color, and finish as the metal to which applied.

1. Expansion Anchors: Provide 5/8in. diameter expansion anchors. Minimum concrete embedment shall be 6in. Design values listed shall be as tested according to ASTM E 488.

2. Lag Screws and Bolts: ASME B18.2.1, type and grade best suited for the purpose.

3. Bolts, Nuts, Studs and Rivets: ASME B18.2.2 and ASTM A 687 or ASTM A 307

4. Washers: Provide plain washers to conform to ASME B18.22.1

2.2 FABRICATION FINISHES

A. Galvanizing

1. Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A 123/A 123M, ASTM A 153/A 153M, ASTM A 653/A 653M or ASTM A 924/A 924M, G90, as applicable.

B. Galvanize

1. Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

C. Repair of Zinc-Coated Surfaces

1. Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A 780 or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove

slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallic in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

D. Shop Cleaning and Painting

1. Surface Preparation

a. Blast clean surfaces in accordance with SSPC SP 6. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2. Pretreatment, Priming and Painting

a. Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.3 EXTERIOR SECURITY GATE

A. Fabricate swing-type security gate from steel pipe and shapes in accordance with the drawing details and fabricator's shop drawings. Swing gate to be lockable, with padlock furnished in Section 08 71 00, to a fixed latch post. Embed the hinge post and the latch post in concrete per the drawing details. All portions of the gate assembly are to shop primed for field finish painting.

2.4 TRENCH COVER PLATES AND FRAMES

A. Fabricate trench cover plates and frames from smooth steel plate and steel tubes in accordance with the drawing details and the fabricator's shop drawings. The length of the trench cover sections is to be limited such that the cover section does not exceed 50 pounds in weight. Include lifting holes on each cover plate section. Fabricate embedded still angles for trench cover support in accordance with drawing details. The embedded steel angles and the trench covers are to be hot dipped galvanized.

2.5 GUARD POSTS (BOLLARDS/PIPE GUARDS)

A. Provide 1/4 inch galvanized prime coated weight steel pipe as specified in ASTM A 53/A 53M.

B. Anchor posts in concrete and fill solidly with concrete with minimum compressive strength per BDS

2.6 MISCELLANEOUS PLATES AND SHAPES

A. Provide angles and plates, ASTM A 36/A 36M, for embedment as indicated. Galvanize embedded items exposed to the elements according to ASTM A 123/A 123M.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified.

Poor matching of holes for fasteners shall be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Form joints exposed to the weather shall be formed to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

A. Provide miscellaneous metalwork that is well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections of work in place and ground smooth. Provide a smooth finish on exposed surfaces of work in place and unless otherwise approved, flush exposed riveting. Mill joints where tight fits are required. Corner joints shall be coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fastened in place. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

A. Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 BUILT-IN WORK

A. Form for anchorage metal work built-in with concrete or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

3.5 WELDING

A. Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.6 FINISHES

A. Field Preparation

1. Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, shall be free of rust, grease, dirt and other foreign matter.

B. Environmental Conditions

1. Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

3.7 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

A. Set pipe guards vertically in concrete piers. Construct piers of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 3000 psi.

END OF SECTION 05 50 13

SECTION 05 51 19

METAL GRATING STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes industrial-type, straight-run stairs with steel-grating treads and railings attached to metal grating stairs.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments.

C. Delegated-Design Submittal: For stairs, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to L/360.

C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.5.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

E. Wire Rod for Grating Crossbars: ASTM A 510.

F. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

G. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.

D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

E. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Form exposed work with accurate angles and surfaces and straight edges.

C. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

D. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel plates or channels.
   a. Provide closures for exposed ends of channel stringers.
2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.

C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded or pressure-locked steel grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c.
2. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 1/2 inch in least dimension.
3. Surface: Serrated.
4. Finish: Shop primed.
5. Fabricate grating treads with cast-abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
6. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.7 STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

1. Fabricate newels of square steel tubing and provide newel caps of pressed steel, as shown.
2. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
3. Connect posts to stair framing by direct welding unless otherwise indicated.

2.8 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel-stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, nonshrink grout unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 51 19

SECTION 06 16 00

SHEATHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall sheathing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review air-barrier and water-resistant glass-mat gypsum sheathing requirements and installation, special details, transitions, mockups, air-leakage testing, protection, and work scheduling that covers air-barrier and water-resistant glass-mat gypsum sheathing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. For air-barrier and water-resistant glass-mat gypsum sheathing, include manufacturer's technical data and tested physical and performance properties of products.

B. Shop Drawings: For air-barrier and water-resistant glass-mat gypsum sheathing assemblies.

1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
3. Include details of interfaces with other materials that form part of air barrier.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of air-barrier and water-resistant glass-mat gypsum sheathing.

1. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

B. Testing Agency Qualifications:

1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
2. For testing and inspecting agency providing tests and inspections related to air-barrier and water-resistant glass-mat gypsum sheathing: an independent agency, qualified according to ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.2 WALL SHEATHING

A. Plywood Sheathing: , Exterior sheathing.

1. Span Rating: Not less than 24/0.
2. Nominal Thickness: Not less than 1/2 inch.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
2. For wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.

1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.

2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

2.4 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in the ICC's International Residential Code for One- and Two-Family Dwellings.
3. ICC-ES evaluation report for fastener.

D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 FIELD QUALITY CONTROL

A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.

B. Testing and Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.

C. Inspections: Air-barrier and water-resistant glass-mat gypsum sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Compatible materials have been used.

2. Transitions at changes in direction and structural support at gaps have been provided.
3. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
4. All penetrations have been sealed.

D. Air barriers will be considered defective if they do not pass tests and inspections.

E. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

F. Prepare test and inspection reports.

END OF SECTION 06 16 00

SECTION 07 21 00

THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic board.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded Polystyrene Board, Type VI: ASTM C578, Type VI, 40-psi minimum compressive strength; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Chemical Company (The).

b. Owens Corning.

c. CertainTeed

2.2 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 07 21 00

SECTION 07 26 00

VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polyethylene vapor retarders.
2. Reinforced-polyethylene vapor retarders.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for under-slab vapor retarders.
2. Section 07 21 00 "Thermal Insulation" for vapor retarders integral with insulation products.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 POLYETHYLENE VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D4397, 6-mil-thick sheet, with maximum permeance rating of 0.1 perm.

2.2 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Place vapor retarders on side of construction indicated on Drawings.

B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 07 26 00

SECTION 07 72 53

SNOW GUARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rail-type, flat-mounted snow guards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Rail-Type Snow Guards: Bracket and 12-inch-long rail.

a. For units with factory-applied finishes, submit manufacturer's standard color selections.

D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating point of failure of attachment to roof system identical as that used on this Project.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design snow guards, including attachment to building, based on the following:

1. Roof snow load.
2. Snow drifting

3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 2.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

A. Flat-Mounted, Rail-Type Snow Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. IceBlox Inc.

b. S-5! Attachment Solutions; Metal Roof Innovations, Ltd.

2. Description: Units fabricated from metal baseplate anchored to fixed bracket and equipped with two bars, rails, or pipes.
3. Brackets and Baseplate: Aluminum; mill finished.
4. Bars: Aluminum; mill finished.

a. Profile: Round.

5. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless-steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as indicated on Shop Drawings.
2. Space rows as recommended by manufacturer.

B. Attachment for Exposed Fastened Metal Roofing:

1. Do not use fasteners that will void metal roofing finish warranty.

2. Flat-Mounted, Rail-Type Snow Guards:

   a. Install brackets in straight rows.
   b. Mechanically fasten to metal roofing, using sealant and mechanical fasteners identical to those used to secure metal roofing to substrate.
   c. Install cross members to brackets.

END OF SECTION 07 72 53

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Immersible joint sealants.
5. Silyl-terminated polyether joint sealants.
6. Mildew-resistant joint sealants.
7. Polysulfide joint sealants.
8. Butyl joint sealants.
9. Latex joint sealants.

B. Related Requirements:

1. Section 07 91 00 "Preformed Joint Seals" for preformed compressible foam and precured joint seals.
2. Section 07 92 19 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
3. Section 32 13 73 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.

C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

F. Field-Adhesion-Test Reports: For each sealant application tested.

G. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.

C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.6 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

A. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.

b. Sika Corporation; Joint Sealants.

c. The Dow Chemical Company.

2.3 URETHANE JOINT SEALANTS

A. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. LymTal International Inc.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

   a. Concrete.

   b. Masonry.

   c. Unglazed surfaces of ceramic tile.

   d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

   a. Metal.

   b. Glass.

   c. Porcelain enamel.

   d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.
4. Provide flush joint profile according to Figure 8B in ASTM C1193.
5. Provide recessed joint configuration of recess depth and according to Figure 8C in ASTM C1193.
    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:
    a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

   a. Whether sealants filled joint cavities and are free of voids.

   b. Whether sealant dimensions and configurations comply with specified requirements.

   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.

1. Joint Locations:

   a. Isolation and contraction joints in cast-in-place concrete slabs.

   b. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, M, P, 50, T, NT.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

   a. Construction joints in cast-in-place concrete.

   b. Joints between metal panels.

   c. Joints between different materials listed above.

d. Perimeter joints between materials listed above and frames of doors and louvers.

e. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

C. Joint-Sealant Application: Concealed mastics.

1. Joint Locations:

a. Aluminum thresholds.

b. Sill plates.

c. Other joints as indicated on Drawings.

2. Joint Sealant: Butyl-rubber based.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 92 00

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Exterior hollow metal doors and frames.

B. Related Requirements:

1. Section 08 71 00 "Door Hardware" for door hardware for hollow-metal doors.

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.3 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amweld Building Products, LLC.
2. Ceco Door Products; an Assa Abloy Group company.
3. Curries Company; an Assa Abloy Group company.
4. Fleming Door Products Ltd.; an Assa Abloy Group company.
5. Steelcraft; an Ingersoll-Rand company.

2.2 STANDARD HOLLOW METAL DOORS AND FRAMES

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: 1500 Series 1 ¾ Full flush solid core door insulated.
2. Core Construction: Manufacturer's standard, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
    a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
    b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
        1) Locations: Exterior doors.
3. Vertical Edges for Single-Acting Doors: Beveled edge.
    a. Beveled Edge: 1/8 inch in 2 inches.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 1 (Full Flush).
2. All exterior doors to be insulated.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.3 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.

3. Postinstalled Expansion Anchor: Minimum 3/8-inch-diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.5 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

C. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

D. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 08 80 00 "Glazing."

2.6 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.

2. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.

2.7 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
   a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
   b. Install frames with removable stops located on secure side of opening.
2. Floor Anchors: Secure with postinstalled expansion anchors.
3. Solidly pack mineral-fiber insulation inside frames.
4. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
   1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 REPAIR

A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulated service doors.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
5. Show locations of controls, locking devices, and other accessories.
6. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish on the following components, in manufacturer's standard sizes:

1. Curtain slats.
2. Bottom bar.
3. Guides.
4. Brackets.
5. Hood.
6. Locking device(s).
7. Include similar Samples of accessories involving color selection.

1.3 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

C. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

B. Structural Performance, Exterior Doors: Capable of withstanding the following design wind loads:

1. Design Wind Load: As indicated on Drawings.
2. Testing: According to ASTM E330/E330M.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under design wind load, acting inward and outward.

C. Windborne-Debris Impact Resistance: Provide impact-protective overhead coiling doors that pass ASTM E1886 missile-impact and cyclic-pressure tests according to ASTM E1996 for Wind Zone 1 for basic protection.

1. Large-Missile Test: For overhead coiling doors located within 30 feet of grade.

D. Seismic Performance: Overhead coiling doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.3 DOOR ASSEMBLY

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Cookson Company.

      b. Cornell.

      c. Overhead Door Corporation.

B. Operation Cycles: Door components and operators capable of operating for not less than 100,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

   1. Include tamperproof cycle counter.

C. Air Infiltration: Maximum rate of 1.0 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E283.

D. STC Rating: 26.

E. Curtain R-Value: 4.5 deg F x h x sq. ft./Btu.

F. Door Curtain Material: Galvanized steel.

G. Door Curtain Slats: Curved profile slats of 1-7/8-inch center-to-center height.

   1. Insulated-Slat Interior Facing: Metal.
   2. Gasket Seal. Manufacturer's standard continuous gaskets between slats.

H. Bottom Bar: Two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch thick; fabricated from hot-dip galvanized steel and finished to match door.

I. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats.

J. Hood: Match curtain material and finish .

   1. Shape: Round.
   2. Mounting: Face of wall.

K. Locking Devices: Equip door with locking device assembly.

   1. Locking Device Assembly: Single-jamb side locking bars, operable from inside with thumbturn.

L. Electric Door Operator:

   1. Usage Classification: Heavy duty, 25 or more cycles per hour and more than 90 cycles per day.
   2. Operator Location: Wall.
   3. Safety: Listed according to UL 325 by a qualified testing agency for commercial or industrial use.
   4. Motor Exposure: Interior.
   5. Motor Electrical Characteristics:

      a. Horsepower: 1-1/2 hp.
      b. Voltage: 460-V ac, three phase, 60 Hz.

6. Emergency Manual Operation: Chain type.
7. Obstruction-Detection Device: Automatic photoelectric sensor.

    a. Sensor Edge Bulb Color: As selected by Architect from manufacturer's full range.

8. Control Station(s): Interior mounted.
9. Other Equipment: .

M. Curtain Accessories: Equip door with weatherseals and automatic-closing device.

N. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Color as selected by Architect from manufacturer's full range.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.4 MATERIALS, GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.
3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.6 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch-thick, hot-dip galvanized-steel sheet with G90 zinc coating, complying with ASTM A653/A653M.

2.7 LOCKING DEVICES

A. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.8 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use 1/8-inch-thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch-thick seals of flexible vinyl, rubber, or neoprene.

B. Poll Hooks: Provide pole hooks and poles for doors more than 84 inches high.

2.9 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. of span under full load.

C. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.10 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.

1. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position,

at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.

2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

   a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained or constant pressure on close button.

G. Control Station: Three-button control station in fixed location with momentary-contact push-button controls labeled "Open" and "Stop" and sustained- or constant-pressure push-button control labeled "Close."

1. Interior-Mounted Units: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

2.11 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.12 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.

D. Power-Operated Doors: Install according to UL 325.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and to furnish reports to Architect.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Test door release, closing, and alarm operations when activated by smoke detector or building's fire-alarm system. Test manual operation of closed door. Reset door-closing mechanism after successful test.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.5 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of coiling-door Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Perform maintenance, including emergency callback service, during normal working hours.
2. Include 24-hour-per-day, seven-day-per-week, emergency callback service.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 08 33 23

SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:

   a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.

B. Related Requirements:

1. Section 08 11 13 "Hollow Metal Doors and Frames".

1.2 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples: For each exposed product in each finish specified, in manufacturer's standard size.

1. Tag Samples with full product description to coordinate Samples with door hardware schedule.

C. Samples for Initial Selection: For each type of exposed finish.

D. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
d. Fastenings and other installation information.
e. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
f. Mounting locations for door hardware.
g. List of related door devices specified in other Sections for each door and frame.

E. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Architectural Hardware Consultant.

B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final keying schedule.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Structural failures including excessive deflection, cracking, or breakage.
   b. Faulty operation of doors and door hardware.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
   a. Exit Devices: Two years from date of Substantial Completion.
   b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

B. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design" the ABA standards of the Federal agency having jurisdiction ICC A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 SCHEDULED DOOR HARDWARE

A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.

1. Door hardware is scheduled on Drawings Insert location.

2.4 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Bommer Industries, Inc.

b. McKinney Products Company; an ASSA ABLOY Group company.

c. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

E. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Best Access Systems; Stanley Security Solutions, Inc.

b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.

c. Marks USA.

d. SARGENT Manufacturing Company; ASSA ABLOY.

e. Stanley Commercial Hardware; a division of Stanley Security Solutions.

f. Yale Security Inc; an ASSA ABLOY Group company.

2.6 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Best Access Systems; Stanley Security Solutions, Inc.

b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.

c. SARGENT Manufacturing Company; ASSA ABLOY.

d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

e. Yale Security Inc; an ASSA ABLOY Group company.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

1. Core Type: Interchangeable.

C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.7 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.

1. No Master Key System: Only change keys operate cylinders.

a. Provide three cylinder change keys.

2. Master Key System: Change keys and a master key operate cylinders.

a. Provide three cylinder change keys and five master keys.

3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinders.

a. Provide three cylinder change keys and five each of master and grand master keys.

4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.

a. Provide three cylinder change keys and five each of master, grand master, and great-grand master keys.

5. Existing System (to match existing key system on-site):

a. Master key or grand master key locks to Owner's existing system.
b. Re-key Owner's existing master key system into new keying system.

6. Keyed Alike: Key all cylinders to same change key.

B. Keys: .

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: Information to be furnished by Owner.

2.8 OPERATING TRIM

A. Operating Trim: BHMA A156.6; brass unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.

b. Trimco.

2.9 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Builders Hardware Mfg., Inc.

b. Hager Companies.

c. Trimco.

2.10 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.

b. M-D Building Products, Inc.

c. Pemko Manufacturing Co.

B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:

1. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.

2.11 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. M-D Building Products, Inc.

b. Pemko Manufacturing Co.

c. Rixson Specialty Door Controls; an ASSA ABLOY Group company.

2.12 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick brass; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hager Companies.

b. Trimco.

2.13 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
3. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.14 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.

E. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."

F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.

B. Occupancy Adjustment: Approximately 6 months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

END OF SECTION 08 71 00

SECTION 08 91 16

OPERABLE WALL LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Operable, extruded-aluminum louvers.

B. Related Requirements:

1. Section 09 91 13 "Exterior Painting" for field painting exterior louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized operable louvers.

C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Sample Warranties: For manufacturer's special warranties.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M.

2. AWS D1.3/D1.3M.
3. AWS D1.6/D1.6M.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 WARRANTY

A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
    a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain operable louvers from single source from single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

B. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

C. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

2.3 OPERABLE EXTRUDED-ALUMINUM LOUVERS

A. Louver Construction and Operation: Provide operable louvers with extruded-aluminum frames and blades of not less than 0.080-inch nominal thickness, and with operating mechanisms to suit louver sizes.

1. Motor operation with two-direction, 110-V, 60-Hz motor and limit switches; equipped with terminals for controlling devices.

B. Dual-Blade Operable Louver: Fixed drainable blades and operable plain blades combined in single frame.

1. Louver Depth: 6 inches, overall.
2. Fixed Drainable-Blade Angle: 35 to 45 degrees.
3. Louver Performance Ratings:
    a. Free Area: Not less than 7.0 sq. ft. for 48-inch-wide by 48-inch-high louver.
    b. Point of Beginning Water Penetration: Not less than 1000 fpm.

c. Air Performance: Not more than 0.10-inch wg static pressure drop at 700-fpm free-area intake velocity.

d. Air Leakage: Not more than 3.5 cfm/sq. ft. of louver gross area at a differential static pressure of 0.15-inch wg with operable louver blades closed.

4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location: Interior face unless otherwise indicated.

2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 16 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached.

2. Finish: Mill finish unless otherwise indicated.

3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch thick.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.

3. For color-finished louvers, use fasteners with heads that match color of louvers.

2.6 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Exterior flange unless otherwise indicated.

C. Include supports, anchorages, and accessories required for complete assembly.

D. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.

E. Provide subsills made of same material as louvers or extended sills for recessed louvers.

F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.7 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Color Anodic Finish: AAMA 611, AA-M10C22A42/A44, Class I, 0.7 mil or thicker.

1. Options in "Color" Subparagraph above are examples only and may vary in color range and availability among manufacturers. Retain one or delete all above and retain one of two options in "Color" Subparagraph below.

2. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 16

SECTION 09 91 13

EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following exterior substrates:

1. Galvanized metal.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for shop priming metal fabrications.

1.2 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system.

a. Vertical and Horizontal Surfaces: Provide samples of at least 64 sq. ft..
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.

2. PPG Paints.

3. Sherwin-Williams Company (The).

B. Products: Subject to compliance with requirements, provide one of the products listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: Per Owner direction from Manufacturer’s standard color palette.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Wood: 15 percent.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Wood Substrates:

1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Galvanized-Metal Substrates:

1. Latex System MPI EXT 5.3A:

a. Prime Coat: Primer, galvanized, cementitious, MPI #26.

b. Intermediate Coat: Latex, exterior, matching topcoat.

c. Topcoat: Latex, exterior, low sheen (MPI Gloss Level 3-4), MPI #15.

END OF SECTION 09 91 13

SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.

b. Guardian Fire Equipment, Inc.

c. JL Industries, Inc.; a division of the Activar Construction Products Group.

d. Kidde Residential and Commercial Division.

e. Larsens Manufacturing Company.

2. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.
3. Valves: Manufacturer's standard.
4. Handles and Levers: Manufacturer's standard.
5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amerex Corporation.

b. Guardian Fire Equipment, Inc.

c. JL Industries, Inc.; a division of the Activar Construction Products Group.

d. Kidde Residential and Commercial Division.

e. Larsens Manufacturing Company.

2. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Per Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: Top of fire extinguisher to be at 48” above finished floor.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10 44 16

SECTION 13 34 19

METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Metal roof panels.
3. Metal wall panels.
4. Metal soffit panels.
5. Thermal insulation.
6. Windows.
7. Accessories.

B. Related Requirements:

1. Section 08 33 23 "Overhead Coiling Doors" for overhead coiling doors in metal building systems.

1.2 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

1.3 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:
    a. Condition of foundations and other preparatory work performed by other trades.
    b. Structural load limitations.
    c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.
    d. Required tests, inspections, and certifications.
    e. Unfavorable weather and forecasted weather conditions and impact on construction schedule.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:
   a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.
   b. Structural limitations of purlins and rafters during and after roofing.
   c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
   d. Temporary protection requirements for metal roof panel assembly during and after installation.
   e. Roof observation and repair after metal roof panel installation.
3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:
   a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.
   b. Structural limitations of girts and columns during and after wall panel installation.
   c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.
   d. Temporary protection requirements for metal wall panel assembly during and after installation.
   e. Wall observation and repair after metal wall panel installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Metal roof panels.
      b. Metal wall panels.
      c. Metal soffit panels.
      d. Thermal insulation and vapor-retarder facings.
      e. Windows.
      f. Translucent roof panels.
      g. Roof ventilators.
      h. Louvers.

B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:
   1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each location.
   2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

3. Metal Roof and Wall Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
   a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
   b. Show wall-mounted items including personnel doors, vehicular doors, windows, louvers, and lighting fixtures.
4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
   a. Flashing and trim.
   b. Gutters.
   c. Downspouts.

C. Samples for Initial Selection: For units with factory-applied finishes.

D. Delegated-Design Submittal: For metal building systems.
   1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For erector manufacturer.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:
   1. Name and location of Project.
   2. Order number.
   3. Name of manufacturer.
   4. Name of Contractor.
   5. Building dimensions including width, length, height, and roof slope.
   6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
   7. Governing building code and year of edition.
   8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
   9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
   10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to the International Accreditation Service's AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

1.10 FIELD CONDITIONS

A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Finish Warranty Period: 25 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. A&S Building Systems, Inc.; a division of NCI.
2. ACI Building Systems, Inc.
3. Alliance Steel, Inc.
4. American Buildings Company; a Nucor Company.
5. Behlen Mfg. Co.
6. Butler Manufacturing Company; a division of BlueScope Buildings North America, Inc.
7. Ceco Building Systems; an NCI company.
8. Garco Building Systems; a division of NCI.
9. Nucor Building Systems
10. Approved Equal

B. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

2.2 SYSTEM DESCRIPTION

A. Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

C. End-Wall Framing: Manufacturer's standard, for buildings not required to be expandable, consisting of primary frame, capable of supporting one-half of a bay design load, and end-wall columns.

D. Secondary-Frame Type: Manufacturer's standard purlins and joists and exterior-framed (bypass) girts.

E. Eave Height: Manufacturer's standard height, as indicated by nominal height on Drawings.

F. Bay Spacing: As indicated on Drawings.

G. Roof Slope: As indicated on Drawings.

H. Roof System: Manufacturer's standard standing-seam, trapezoidal-rib, metal roof panels.

1. Liner Panels: Tapered rib.

I. Exterior Wall System: Manufacturer's standard exposed-fastener, tapered-rib, metal wall panels.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design metal building system.

B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on structural Drawings.

2. Deflection and Drift Limits: Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."

3. Deflection and Drift Limits: No greater than the following:

a. Purlins and Rafters: Vertical deflection of 1/240 of the span.

b. Girts: Horizontal deflection of 1/180 of the span.

c. Metal Roof Panels: Vertical deflection of 1/240 of the span.

d. Metal Wall Panels: Horizontal deflection of 1/180 of the span.

e. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

f. Lateral Drift: Maximum of 1/100 of the building height.

C. Seismic Performance: Metal building system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

E. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.

F. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

G. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

H. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

I. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

J. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

K. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM

Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A- 90.

L. Solar Reflectance Index (SRI): Three-year-aged SRI not less than 64 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

2.4 STRUCTURAL-STEEL FRAMING

A. Recycled Content: Building materials shall have recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content for Project constitutes a minimum of 10 percent of cost of materials used for Project.

B. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

C. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

D. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

E. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

    a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

3. Frame Configuration: see drawings

4. Exterior Column: Tapered.

5. Rafter: Uniform depth.

F. End-Wall Framing: Manufacturer's standard primary end-wall framing fabricated for field-bolted assembly to comply with the following:

1. End-Wall and Corner Columns: I-shaped sections fabricated from structural-steel shapes; shop-welded, built-up steel plates; or C-shaped, cold-formed, structural-steel sheet.

2. End-Wall Rafters: C-shaped, cold-formed, structural-steel sheet; or I-shaped sections fabricated from shop-welded, built-up steel plates or structural-steel shapes.

G. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch-wide flanges.

    a. Depth: As needed to comply with system performance requirements.

2. Purlins: Steel joists of depths indicated on Drawings.

3. Girts: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch-wide flanges.
   a. Depth: As required to comply with system performance requirements.
4. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
5. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch-diameter, cold-formed structural tubing to stiffen primary-frame flanges.
6. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
7. Base or Sill Angles: Manufacturer's standard base angle, minimum 3-by-2-inch, fabricated from zinc-coated (galvanized) steel sheet.
8. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
9. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

H. Bracing: Provide adjustable wind bracing using any method required as follows:
1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50; or ASTM A529/A529M, Grade 50; minimum 1/2-inch-diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Cable: ASTM A475, minimum 1/4-inch-diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Rigid Portal Frames: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
5. Fixed-Base Columns: Fabricated from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.
6. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

I. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

J. Materials:
1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.

6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60 coating designation; mill phosphatized.
8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.
   a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G90 coating designation.
   b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80; with Class AZ50 coating.
9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.
10. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M,Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
11. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1 hardened carbon-steel washers.

K. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.
   1. Clean and prepare in accordance with SSPC-SP2.
   2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.
      a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2.5 METAL ROOF PANELS

A. Exposed Fastener, Tapered-Rib, Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
   1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
      a. Exterior Finish: Two-coat fluoropolymer.
      b. Color: As selected by Owner from manufacturer's full range.
   2. Major-Rib Spacing: 12 inches o.c.
   3. Panel Coverage: 36 inches.
   4. Panel Height: 1.25 inches.

B. Finishes:

1. Exposed Coil-Coated Finish:
   a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 METAL WALL PANELS

A. Exposed-Fastener, Tapered-Rib, Metal Wall Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
   1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
      a. Exterior Finish: Two-coat fluoropolymer.
      b. Color: As selected by Owner from manufacturer's full range.
   2. Major-Rib Spacing: 12 inches o.c.
   3. Panel Coverage: 36 inches.
   4. Panel Height: 1.25 inches.

B. Exposed-Fastener, Reverse-Rib, Metal Wall Panels: Formed

C. Finishes:
   1. Exposed Coil-Coated Finish:
      a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2.7 THERMAL INSULATION

A. Unfaced Metal Building Insulation: ASTM C991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Mineral-Fiber-Blanket Insulation: ASTM C665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.
   1. Unfaced: Type I (blankets without membrane covering), passing ASTM E136 for combustion characteristics.

C. Retainer Strips: For securing insulation between supports, 0.025-inch nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

D. Vapor-Retarder Facing: ASTM C1136, with permeance not greater than 0.02 perm when tested according to ASTM E96/E96M, Desiccant Method.
   1. Composition: White polypropylene film facing and fiberglass-polyester-blend fabric backing.

E. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.8 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
3. Cleats: Manufacturer's standard, mechanically seamed cleats.
4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.
2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.

2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot-long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Roof Ventilators: See mechanical drawings.

H. Louvers: Size and design indicated; self-framing and self-flashing. Fabricate welded frames from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.048-inch nominal uncoated steel thickness; finished to match metal wall panels. Form blades from zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.036-inch nominal uncoated steel thickness; folded or beaded at edges, set at an angle that excludes driving rains, and secured to frames by riveting or welding. Fabricate louvers with equal blade spacing to produce uniform appearance.

I. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

1. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

3. Metal Panel Sealants:

a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.

b. Joint Sealant: ASTM C920; one part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.9 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.

2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.
2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.
5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.
2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.

2. Locate and space wall girts to suit openings such as doors and windows.

3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Steel Joists and Joist Girders: Install joists, girders, and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Standard Specifications and Load Tables for Steel Joists and Joist Girders," joist manufacturer's written instructions, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.

2. Space, adjust, and align joists accurately in location before permanently fastening.

3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.

4. Joist Installation: Bolt joists to supporting steel framework using carbon-steel bolts unless otherwise indicated.

5. Joist Installation: Bolt joists to supporting steel framework using high-strength structural bolts unless otherwise indicated. Comply with RCSC's "Specification for Structural Joints

Using High-Strength Bolts" for high-strength structural bolt installation and tightening requirements.

6. Joist Installation: Weld joist seats to supporting steel framework.
7. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

I. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
   1. Tighten rod and cable bracing to avoid sag.
   2. Locate interior end-bay bracing only where indicated.
J. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
K. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
C. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
   1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
D. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
      a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
   2. Install metal panels perpendicular to structural supports unless otherwise indicated.
   3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
   4. Locate and space fastenings in uniform vertical and horizontal alignment.
   5. Locate metal panel splices over structural supports with end laps in alignment.
   6. Lap metal flashing over metal panels to allow moisture to run over and off the material.
E. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

F. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.

2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

C. Installation Tolerances: Shim and align metal wall panels within installed tolerance of 1/4 inch in 20 feet, noncumulative; level, plumb, and on location lines; and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

B. Blanket roof insulation: comply with the following installation method:

1. Two-layers-“simple saver system”-with-spacer-block installation: install the painted tensioned metal straps and vapor retarder below the bottom plane of the purlins. Layer the bottom layer of insulation to completely fill the space between purlins. Install top layer of insulation over and perpendicular to the purlins. Hold in place with bands and crossbands below insulation.
2. Thermal spacer blocks: where metal roof panels attach directly to purlins, install thermal spacer blocks.
3. Retainer strips: install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket wall insulation: extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer strips: install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.8 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

2. Tie downspouts to underground drainage system indicated.

E. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

F. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.9 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Doors: After completing installation, test and adjust doors to operate easily, free of warp, twist, or distortion.

3.11 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."

2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

D. Touchup Painting: Cleaning and touchup painting are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

F. Windows: Clean metal surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances. Clean factory-glazed glass immediately after installing windows.

G. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

END OF SECTION 13 34 19

SECTION 13 34 23.19

FABRICATED DOME STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes leachate tank domes (one each) for leachate tanks 219A201 and 219E201.

B. References

1. *Aluminum Design Manual*, Aluminum Association, 2015.
2. ASCE 7-10, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*.
3. *ASME Boiler and Pressure Vessel Code*
4. ASTM C509, *Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material*
5. ASTM F593, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*
6. AWS D1.1, *Structural Welding Code - Steel*
7. AWS D1.2, *Structural Welding Code - Aluminum*
8. CHPRC-04065, *Tank Cover Support Framing and Foundation Calculations*
9. H-2-830831, Sh. 1, *IDF Site Access/Leachate Storage Partial Plans*
10. H-2-830846, Sh. 1, *IDF Leachate Transfer Piping Plan*
11. H-2-830869, Sh. 1, *IDF Leachate Tank Foundation Plan, Section & Detail*
12. H-2-837973, Sh. 1, *IDF Infrastructure Tank Cover Foundation Plan*
13. H-2-837973, Sh. 2, *IDF Infrastructure Tank Cover Partial Framing Plan*
14. H-2-837973, Sh. 3, *IDF Infrastructure Tank Cover Sections*
15. IBC 2015, *International Building Code*
16. NFPA 780, *Standard for the Installation of Lightning Protection Systems*
17. PRC-PRO-IRM-309, *Controlled Software Management*
18. PRC-STD-EN-40259, *Engineering Calculations*

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for leachate tank domes. The tank dome shall be supported by the foundation per H-2-837973, Sh. 1-3, including 21 equidistant support columns with four sequential columns of reduced height to interface with a raised beam to avoid existing interferences.

2. Each individual tank dome support column reaction shall not exceed those determined in CHPRC-04065:

Support Reaction	Design Level Force
Dead Load	1,300 lbf
Roof Live Load	11,040 lbf
Snow Load	9,500 lbf
Wind Load Uplift	10,900 lbf
Wind Load Down	3,700 lbf
Wind Load Horizontal Outwards	180 lbf
Wind Load Horizontal toward Tank Center	380 lbf
Wind Load Tangential	950 lbf

B. Design Submittal: For leachate tank dome structures, provide a complete structural design calculation stamped by a Professional Engineer registered in Washington State and compliant with PRC-STD-EN-40259, *Engineering Calculations* and satisfying computer software verification and validation requirements in accordance with PRC-PRO-IRM-309.

1. Calculations shall indicate the loadings used in the dome design, as well as factors (if any) applied to obtain these loads. Indicate the controlling load case for each member and the equations to calculate allowable stresses for aluminum structural members.

2. Provide allowable stresses for aluminum and stainless-steel fasteners. Allowable stresses and factors of safety shall be based on the Aluminum Association's "Aluminum Design Manual" for aluminum components, and ASTM F593 for stainless steel components. Material certification shall be provided for the materials used.

3. Provide design load reactions and locations for the support structure anchorage.

4. Provide anchorage calculations to confirm anchorage is adequate to support tank dome structure.

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.

   a. Dome anchorage – provide details for tank anchorage to interface with foundation(s) shown on H-2-837973, Sh. 1-3, including number, location, size, and type of concrete anchors (post-installed preferred) to interface.

   b. Dome Tank Seal – provide details for flashing between tank dome and existing tank walls to prevent access to leachate tank by vermin, insects, birds, etc.

2. Include complete dimensioned details of dome assemblies. Indicate dimensions, gauges, thicknesses, materials, finishes, weights, loads, required clearances, method of field assembly, components, and all connection details including the location and size of each field connection.

   a. Dome Structure – provide a detailed drawing of the dome structure and a completed table of structural member and connection information, indicating piece marks, number of bolts, and diameter at each connection and member flange widths and thicknesses. Piece marks shall correspond to detailed drawing.

b. Dome Sheeting – provide plan view(s) indicating the panel piece marks and their locations in the assembled dome structure and provide a table indicating the overall dimensions of each panel piece mark.

D. Detailed fabrication instructions for assembly of domes.

1. Stamped by a Professional Engineer registered in Washington State.

2. Identify hold points (e.g., bolt torque inspection), critical steps or criteria, and inspection criteria to ensure that domes are properly erected.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Construction drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Leachate tank(s)

2. Leachate tanks and flashing between tank(s) and dome(s)

3. Leachate tank piping connection points

4. Other potential interferences or required interfaces

5. Tank Dome foundation and anchor bolts

B. Qualification Data: For manufacturer, evidence of prior experience designing and fabricating domes at least 100 ft. in diameter. All fabrication work shall be executed by workmen skilled and experienced in the fabrication of aluminum domes.

C. Seismic Qualification Certificates: For tank domes, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Welding certificates.

E. Product Test Reports: For each dome, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For domes, to include in maintenance manuals.

B. Spare Parts List (if required): include ordering information.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel D1.2/D1.2M, "Structural Welding Code – Aluminum."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing – Seller shall prepare tank domes for shipping and define the storage environmental limits.

B. Marking – Seller shall mark and label shipping containers for safety, protection, and identification.

C. Handling – Seller shall specify any handling requirements, including loading and unloading limitations, and any restrictions regarding hooks, bails, forklifts, etc.

D. Shipping – Seller shall arrange for transportation and delivery to the IDF facility. Seller shall specify limitations or special instructions on shipping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide two leachate tank domes from RPS Engineering, Incorporated or comparable product.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified Professional Engineer registered in the state of Washington to design two leachate tank domes.

B. Safety Classification: Domes are General Service (i.e., not directly supporting a nuclear safety function).

C. The structure shall be designed in accordance with ASCE/SEI 7-10 and IBC 2015 as required by PRC-PRO-EN-097. The load cases to be considered shall include the following loads:

1. Dead Load – The dead load shall be defined as the weight of the structure and all material permanently attached to and supported by the structure.

2. Snow Load – The ground snow load as defined in Section 7 of ASCE 7 shall be 15 psf. Importance Factor, I_s = 1.00. Unbalanced snow loads resulting from drifting or sliding shall be considered.

3. Ice Load – I_i = 1.00.

4. Wind Load – The wind load shall be applied in accordance with ASCE 7, Sections 6.5 through 6.7 for an ultimate design wind speed (peak gust) of 110 mph, exposure C. Importance Factor, I_w = 1.00.

5. Seismic Load – domes shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 as required by PRC-PRO-EN-097, *Engineering Design and Evaluation (Natural Phenomena Hazard)*.

    a. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

    b. Component Importance Factor, I_p = 1.00.

    c. Site Class D (Site Class C may be used if soil properties are known).

    d. S_s = 0.46, S_1 = 0.15, F_a = 1.43, F_v = 2.2, S_{ms} = 0.66, S_{m1} = 0.33

6. Ashfall Loads – 3.2 psf; ashfall shall be considered by substituting the ash load, V, for the snow load, S, in the ASCE 7-10 load combinations. Unbalanced ashfall loads shall be considered.

7. Panel Design Load – in addition to the above loadings, the dome panels shall be designed for two concentrated loads of 250 pounds, each applied simultaneously on two separate one square foot areas of the panel and the ground snow load distributed over the entire area of the panel.

D. Anchorage: Expansion anchors shall use any industry standard wedge-type expansion anchor having capacities published by the International Code Council Evaluations Service (ICC-ES) and approved for resistance to wind and seismic loading.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Range: 115°F to -25°F, ambient.
2. Maximum Daily Temperature Range: 50°F.

F. Capacities and Characteristics:

1. Each dome shall enclose the top of the leachate tanks shown on drawing H-2-830869 included in Attachment 1. Dome roof cover supports and required foundation shall not interfere with existing tank walls, existing tank foundation, or ancillary equipment (i.e., piping entering and exiting the tank).
2. Lightning protection in accordance with NFPA 780.
3. The dome shall be a fully triangulated space frame complete with non-corrugated closure panels. The dome shall be clear-span and designed to be self-supporting from the external mounting points with primary horizontal thrust contained by an integral tension ring to avoid imposing radial loads on the support columns.
4. The dome surface panel shall be designed as a watertight system under all load and ambient temperature conditions. All raw edges of the aluminum panels shall be covered, sealed, and firmly clamped with Batten Bars in an interlocking manner to prevent slipping or disengagement under all load and temperature changes. Flashing shall be provided to seal the underside of the dome to the top of the existing leachate tank walls.
5. The external support system shall support the dome under all load conditions.
6. Foundation requirements shall not interfere with the existing tank foundation, piping, equipment, and structures surrounding the tanks.
7. Relief vents for each dome shall be included to allow for pressure variations caused by tank level changes and thermal variations.
8. Each tank dome shall include two adjacent access hatches. One shall be at least 9 inches by 20 inches to provide access to the stilling wells (see H-2-830846 for approximate location of stilling wells). The second access hatch shall be 2.5 feet square for sampling and observation. Both access hatches shall be accessible from the edge of the dome using an appropriately sized platform and metal stairs as specified in 05 51 19, *Metal Grating Stairs*. Access hatches shall include water tight seal. Seller to coordinate with Buyer to determine optimal location of hatches, platform, and stairs.

2.3 MATERIALS

A. All materials furnished to meet the provisions of this specification shall be new, previously unused, and shall comply with all the requirements of this specification. A complete material specification shall by submitted by the Seller for approval by the Buyer. All aluminum alloys, properties and tolerances shall be defined by the Aluminum Association's Aluminum Design Manual, latest edition.

1. Structural Shapes and Plates- Aluminum Alloy 6061-T6 or equal.
2. Panels - 16 gauge (minimum) Aluminum Alloy 3003-H16 or equal. Plates and sheets shall be mill finished.
3. Tension Ring- Aluminum Alloy 6061-T6 or equal.
4. Fasteners - Type 316 stainless steel, aluminum alloy 2024-T4 or anodized aluminum alloy 7075-T73 including flat washers, lock washers and nuts.

5. Sealant- Dow 790 Silicone, FS TT-S-001543A and FS TT-S-00230C, or equal.
6. Gaskets- Neoprene Gasket Conforming with ASTM C-509.
7. Support Bearing Pads- Teflon faced neoprene on stainless steel.
8. Epoxy anchors, Bolts, Flat Washer, Nuts and Lock Washers - Type 316 Stainless Steel.
9. Hardware: Assembly hardware and rail nut plates shall be type 316, stainless steel.
10. Aluminum relief vents and bird screen shall be of Aluminum Alloy 6061-T6 or 3003-H16
11. Aluminum hatches and access doors shall be furnished with lockable hasp and capable of being secured when opened and shall be Aluminum Alloy 6061-T6 or 3003-H16.
12. Provide an aluminum drip edge to channel rainwater off the dome.
13. Provide grounding lugs and mechanical lug mounted to three (3) points of lower dome for grounding of each dome locations. Coordinate final locations with Construction Manager.

2.4 FABRICATION

A. Shop Assembly: Each dome shall be assembled for inspection and confirmation of fit-up prior to packaging for shipment.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Finish products after assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine domes, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for existing piping to verify actual locations of piping connections before dome installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Erect domes in accordance with Seller’s instructions.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

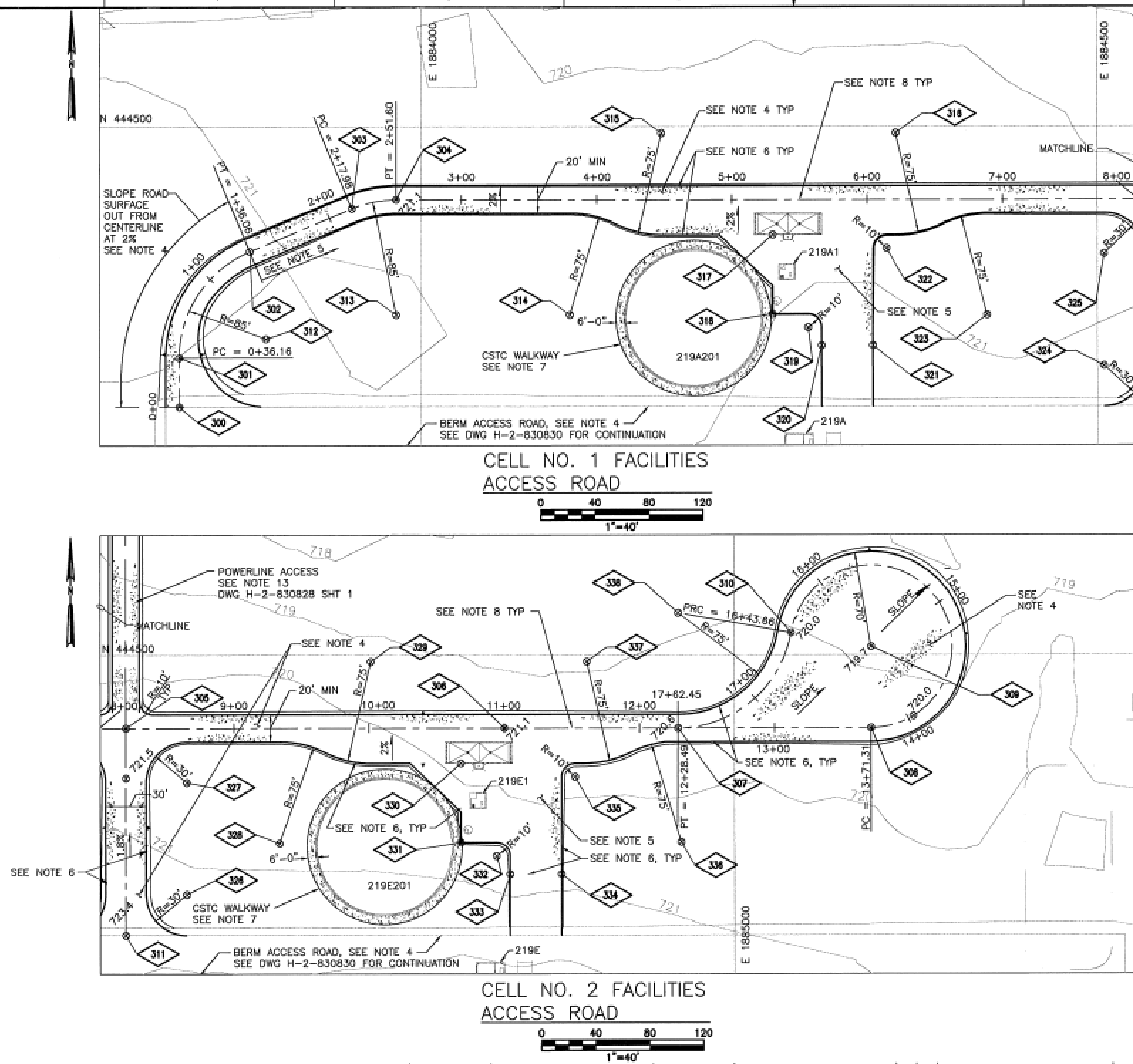
B. The dome(s) will be considered defective if it does not pass inspections.

C. Prepare test and inspection reports.

END OF SECTION 13 34 23.19

SECTION 13 34 23.19 – ATTACHMENT 1

REFERENCE DRAWINGS



NOTES:

1. SEE DWG H-2-830829 SHT 2 FOR SURVEY CONTROL.
2. CONNECT NEW ACCESS ROAD TO 1ST STREET, SEE DWG H-2-830827, NOTE 7.
3. ACCESS ROAD ELEVATIONS SHOWN ARE FINISHED GRADE.
4. SEE 1 & 3 H-2-830835 SHT 2 FOR REQD ROAD SECTION FOR CELLS 1 & 2, FACILITIES ACCESS ROAD AND BERM ACCESS ROAD.
5. GRADE CRUSHED SURFACING UNIFORMLY BETWEEN ELEVATIONS AT CONTROL POINTS. SLOPE TO DRAIN AWAY FROM ALL STRUCTURES. SEE 3 H-2-830835 SHT 2 FOR REQD SURFACING IN THIS AREA, TYP.
6. SEE DETAIL 1 ON DWG H-2-830835 SHT 2 FOR GUIDE POSTS REQD ON BOTH SIDES OF ALL CELLS 1 & 2 FACILITIES ACCESS ROADS.
7. PROVIDE 6 FT WIDE ACCESS WALKWAY CONTINUOUS AROUND EACH LEACHATE STORAGE TANK. CONSTRUCT WALKWAY BY PLACEMENT OF 4-INCH THICK LAYER OF COMPACTED CSTC MATERIAL. SURFACE ELEVATION OF PATH SHALL BE MIN OF 2 INCHES BELOW TOP OF ELEVATION OF TANK'S RINGWALL.
8. FOR THE FACILITY ACCESS ROAD AND POWERLINE ACCESS ROAD, THE PERIMETER SLOPE FOR CUT/FILL TO MEET EXISTING GRADE SHALL BE 2H:1V.

GENERAL NOTE:
ACTUAL DIMENSIONS ARE CONSTRUCTED WITHIN SPECIFIED TOLERANCES OF THE DESIGN DIMENSIONS SHOWN.

SEP 05 2006

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U.S. DEPARTMENT OF ENERGY
Office of River Protection

IDF
SITE ACCESS/LEACHATE STORAGE PARTIAL PLANS

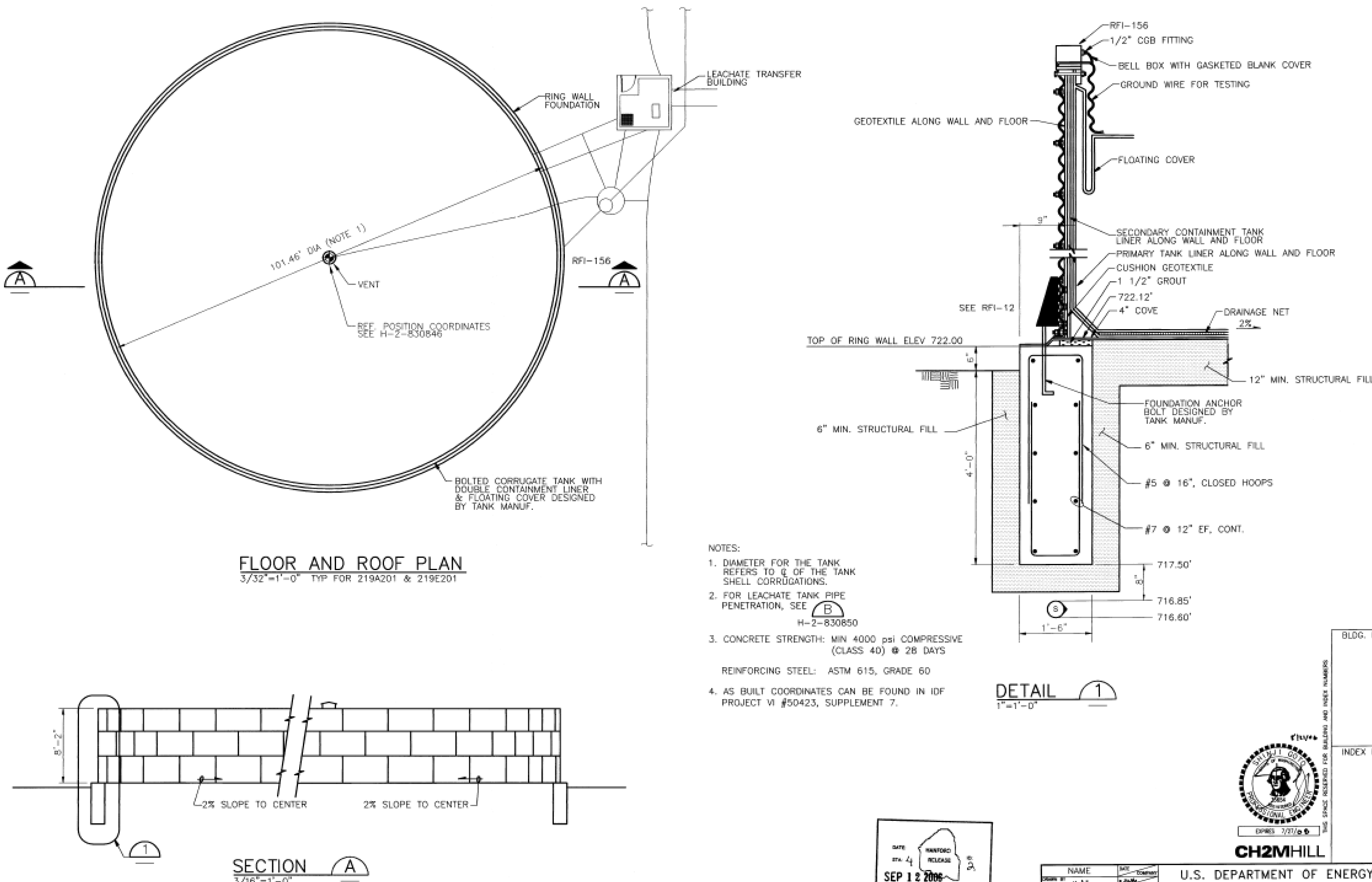
D 2006 0110 H-2-830831 0

SCALE AS SHOWN 822157 SHEET 1 OF 1

SCH 8 AS-BUILTS – TRENCH FCN 100317 & 100321, ECN 723900 REV 0

DWG NO	TITLE	REF NUMBER	TITLE
DRAWING TRACEABILITY LIST		NEXT USED ON	REFERENCES

REVISIONS



NOTES:

1. DIAMETER FOR THE TANK REFERS TO ℄ OF THE TANK SHELL CORRUGATIONS.
2. FOR LEACHATE TANK PIPE PENETRATION, SEE B H-2-830850
3. CONCRETE STRENGTH: MIN 4000 psi COMPRESSIVE (CLASS 40) @ 28 DAYS

   REINFORCING STEEL: ASTM 615, GRADE 60
4. AS BUILT COORDINATES CAN BE FOUND IN IDF PROJECT VI #50423, SUPPLEMENT 7.

HANFORD RELEASE SEP 12 2006

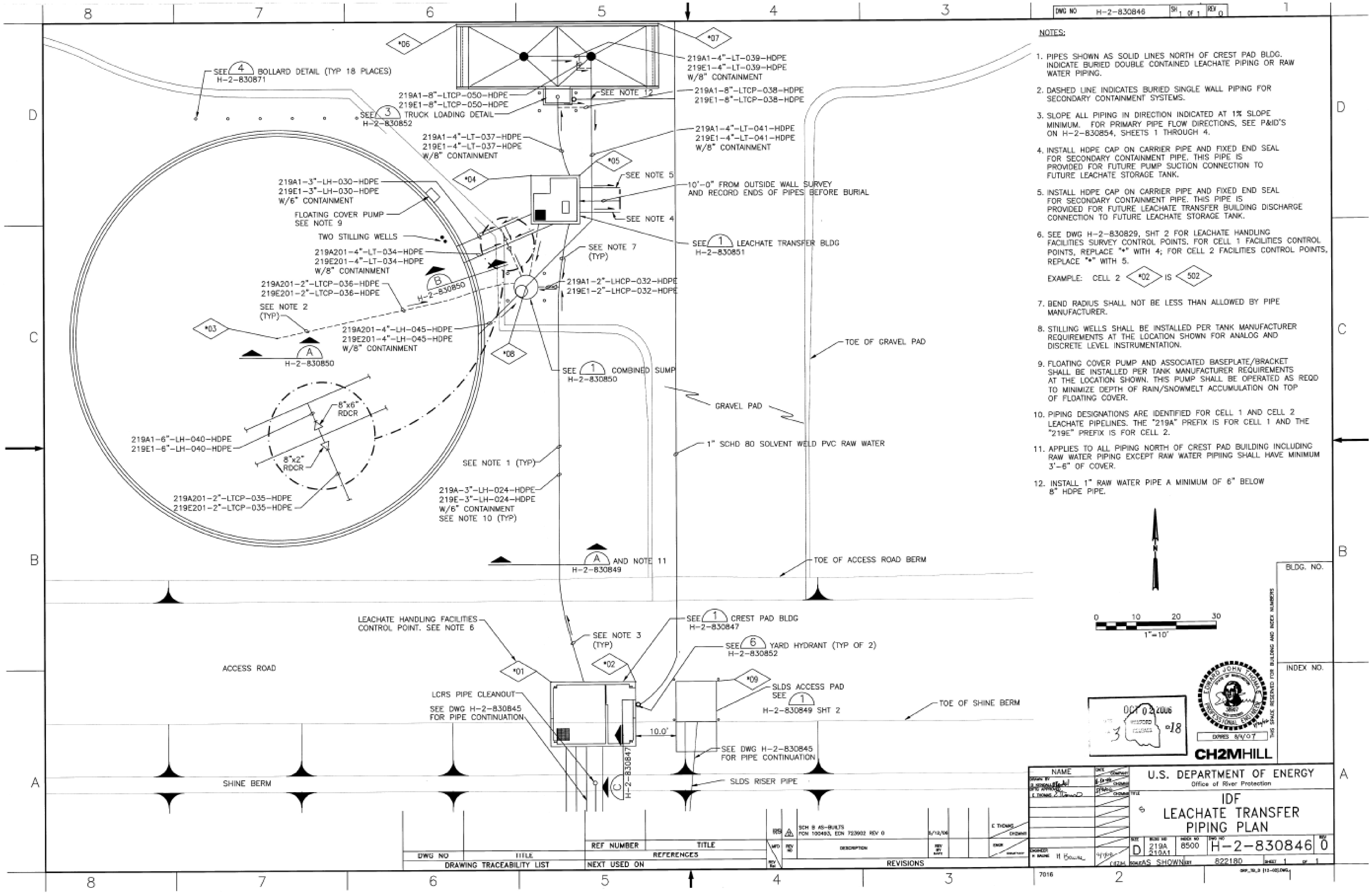
CH2MHILL

U.S. DEPARTMENT OF ENERGY
Office of River Protection

IDF
LEACHATE TANK FOUNDATION
PLAN, SECTION & DETAIL

REV	DESCRIPTION	DATE
0	SCH B AS-BUILTS, FCN-100513, ECN-723901-R0	9/12/06

DWG NO H-2-830869 REV 0 — SHEET 1 OF 1 — SIZE D — BLDG 219A201, 219E201 — SCALE AS SHOWN — B22158


NOTES:
1. PIPES SHOWN AS SOLID LINES NORTH OF CREST PAD BLDG. INDICATE BURIED DOUBLE CONTAINED LEACHATE PIPING OR RAW WATER PIPING.
2. DASHED LINE INDICATES BURIED SINGLE WALL PIPING FOR SECONDARY CONTAINMENT SYSTEMS.
3. SLOPE ALL PIPING IN DIRECTION INDICATED AT 1% SLOPE MINIMUM. FOR PRIMARY PIPE FLOW DIRECTIONS, SEE P&ID'S ON H-2-830854, SHEETS 1 THROUGH 4.
4. INSTALL HDPE CAP ON CARRIER PIPE AND FIXED END SEAL FOR SECONDARY CONTAINMENT PIPE. THIS PIPE IS PROVIDED FOR FUTURE PUMP SUCTION CONNECTION TO FUTURE LEACHATE STORAGE TANK.
5. INSTALL HDPE CAP ON CARRIER PIPE AND FIXED END SEAL FOR SECONDARY CONTAINMENT PIPE. THIS PIPE IS PROVIDED FOR FUTURE LEACHATE TRANSFER BUILDING DISCHARGE CONNECTION TO FUTURE LEACHATE STORAGE TANK.
6. SEE DWG H-2-830829, SHT 2 FOR LEACHATE HANDLING FACILITIES SURVEY CONTROL POINTS. FOR CELL 1 FACILITIES CONTROL POINTS, REPLACE "*" WITH 4; FOR CELL 2 FACILITIES CONTROL POINTS, REPLACE "*" WITH 5.
EXAMPLE: CELL 2 *02 IS 502
7. BEND RADIUS SHALL NOT BE LESS THAN ALLOWED BY PIPE MANUFACTURER.
8. STILLING WELLS SHALL BE INSTALLED PER TANK MANUFACTURER REQUIREMENTS AT THE LOCATION SHOWN FOR ANALOG AND DISCRETE LEVEL INSTRUMENTATION.
9. FLOATING COVER PUMP AND ASSOCIATED BASEPLATE/BRACKET SHALL BE INSTALLED PER TANK MANUFACTURER REQUIREMENTS AT THE LOCATION SHOWN. THIS PUMP SHALL BE OPERATED AS REQD TO MINIMIZE DEPTH OF RAIN/SNOWMELT ACCUMULATION ON TOP OF FLOATING COVER.
10. PIPING DESIGNATIONS ARE IDENTIFIED FOR CELL 1 AND CELL 2 LEACHATE PIPELINES. THE "219A" PREFIX IS FOR CELL 1 AND THE "219E" PREFIX IS FOR CELL 2.
11. APPLIES TO ALL PIPING NORTH OF CREST PAD BUILDING INCLUDING RAW WATER PIPING EXCEPT RAW WATER PIPING SHALL HAVE MINIMUM 3'-6" OF COVER.
12. INSTALL 1" RAW WATER PIPE A MINIMUM OF 6" BELOW 8" HDPE PIPE.
SEE 4 BOLLARD DETAIL (TYP 18 PLACES) H-2-830871
219A1-8"-LTCP-050-HDPE
219E1-8"-LTCP-050-HDPE
SEE 3 TRUCK LOADING DETAIL H-2-830852
219A1-4"-LT-037-HDPE
219E1-4"-LT-037-HDPE
W/8" CONTAINMENT
219A1-3"-LH-030-HDPE
219E1-3"-LH-030-HDPE
W/6" CONTAINMENT
FLOATING COVER PUMP SEE NOTE 9
TWO STILLING WELLS
219A201-4"-LT-034-HDPE
219E201-4"-LT-034-HDPE
W/8" CONTAINMENT
219A201-2"-LTCP-036-HDPE
219E201-2"-LTCP-036-HDPE
SEE NOTE 2 (TYP)
219A201-4"-LH-045-HDPE
219E201-4"-LH-045-HDPE
W/8" CONTAINMENT
A H-2-830850
B H-2-830850
8"x6" RDCR
8"x2" RDCR
219A1-6"-LH-040-HDPE
219E1-6"-LH-040-HDPE
219A201-2"-LTCP-035-HDPE
219E201-2"-LTCP-035-HDPE
219A1-4"-LT-039-HDPE
219E1-4"-LT-039-HDPE
W/8" CONTAINMENT
219A1-8"-LTCP-038-HDPE
219E1-8"-LTCP-038-HDPE
SEE NOTE 12
219A1-4"-LT-041-HDPE
219E1-4"-LT-041-HDPE
W/8" CONTAINMENT
SEE NOTE 5
10'-0" FROM OUTSIDE WALL SURVEY AND RECORD ENDS OF PIPES BEFORE BURIAL
SEE NOTE 4
SEE 1 LEACHATE TRANSFER BLDG H-2-830851
SEE NOTE 7 (TYP)
219A1-2"-LHCP-032-HDPE
219E1-2"-LHCP-032-HDPE
SEE 1 COMBINED SUMP H-2-830850
TOE OF GRAVEL PAD
GRAVEL PAD
1" SCHD 80 SOLVENT WELD PVC RAW WATER
SEE NOTE 1 (TYP)
219A-3"-LH-024-HDPE
219E-3"-LH-024-HDPE
W/6" CONTAINMENT
SEE NOTE 10 (TYP)
A AND NOTE 11 H-2-830849
TOE OF ACCESS ROAD BERM
LEACHATE HANDLING FACILITIES CONTROL POINT. SEE NOTE 6
SEE NOTE 3 (TYP)
SEE 1 CREST PAD BLDG H-2-830847
SEE 6 YARD HYDRANT (TYP OF 2) H-2-830852
ACCESS ROAD
SLDS ACCESS PAD SEE 1 H-2-830849 SHT 2
TOE OF SHINE BERM
LCRS PIPE CLEANOUT
SEE DWG H-2-830845 FOR PIPE CONTINUATION
10.0'
SEE DWG H-2-830845 FOR PIPE CONTINUATION
SLDS RISER PIPE
SHINE BERM
H-2-830847
*01 *02 *03 *04 *05 *06 *07 *08 *09
1"=10'
BLDG. NO.
INDEX NO.
THIS SPACE RESERVED FOR BUILDING AND INDEX NUMBERS
CH2MHILL
U.S. DEPARTMENT OF ENERGY
Office of River Protection
IDF
LEACHATE TRANSFER
PIPING PLAN
219A 210A1
8500
H-2-830846
SCALE AS SHOWN
822180
SHEET 1 OF 1
SCH B AS-BUILTS FCN 100493, ECN 723902 REV 0
REVISIONS
DWG NO TITLE
DRAWING TRACEABILITY LIST
REF NUMBER TITLE
REFERENCES
NEXT USED ON

SECTION 22 11 13

FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service and fire-service mains.

1.2 DEFINITIONS

A. EPDM: Ethylene propylene diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PA: Polyamide (nylon) plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1. Wiring Diagrams: Power, signal, and control wiring for alarms.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of MSA water purveyor. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Construction Manager's written permission.

1.9 COORDINATION

A. Coordinate connection to water main with MSA.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Application" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 PVC PIPE AND FITTINGS

A. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

B. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.

1. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

2.3 SPECIAL PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints:

1. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

   Pressure Rating: 250 psig minimum.

   Expansion Required: 12”.

B. Ductile-Iron Flexible Expansion Joints:

1. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

   Pressure Rating: 250 psig minimum.

   Offset: 0.5”.

   Expansion Required: 12”.

2.4 JOINING MATERIALS

A. Refer to Section 33 05 00 "Common Work Results for Utilities" for commonly used joining materials.

B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.5 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

   Standard: AWWA C219.

   Center-Sleeve Material: Manufacturer's standard.

   Gasket Material: Natural or synthetic rubber.

   Pressure Rating: 150 psig minimum.

   Metal Component Finish: Corrosion-resistant coating or material.

C. Split-Sleeve Pipe Couplings:

1. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

   Standard: AWWA C219.

   Sleeve Material: Manufacturer's standard.

   Sleeve Dimensions: Of thickness and width required to provide pressure rating.

   Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.

Pressure Rating: 150 psig minimum.

Metal Component Finish: Corrosion-resistant coating or material.

D. Flexible Connectors:

1. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

2.6 CORROSION-PROTECTION PIPING ENCASEMENT

A. Encasement for Underground Metal Piping:

1. Standards: ASTM A674 or AWWA C105.
2. Form: Sheet or tube.
3. Material: LLDPE film of 0.008-inch minimum thickness.
4. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
5. Material: High-density, crosslaminated PE film of 0.004-inch minimum thickness.
6. Color: Natural.

2.7 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:

1. OS&Y, Rising-Stem, Metal-Seated Gate Valves:

   Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.

   1) Standard: AWWA C500.
   2) Minimum Pressure Rating: 200 psig.
   3) End Connections: Flanged.

2. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

   Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.

   1) Standard: AWWA C509.
   2) Minimum Pressure Rating: 200 psig.
   3) End Connections: Flanged.

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Description: Sleeve and valve compatible with drilling machine.

   Standard: MSS SP-60.

   Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.

   Valve: AWWA, cast-iron, nonrising-stem, metal-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.9 CHECK VALVES

A. AWWA Check Valves:

1. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.

Standard: AWWA C508.

Pressure Rating: 175 psig.

2.10 FLUSHING HYDRANTS

A. Post-Type Flushing Hydrants:

1. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

Pressure Rating: 150 psig minimum.

Outlet: One, with horizontal discharge.

Hose Thread: NPS 2-1/2, with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.

Barrel: Cast-iron or steel pipe with breakaway feature.

Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.

Security: Locking device for padlock.

Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

Inlet: NPS 2 minimum.

Operating Wrench: One for each unit.

B. Post-Type Sampling Station:

1. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.

Pressure Rating: 100 psig minimum.

Sampling Outlet: One unthreaded nozzle with handle.

Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.

Drain: Tubing with separate manual vacuum pump.

Inlet: NPS 3/4 minimum.

Housing: Weatherproof material with locking device. Include anchor device.

Operating Wrench: One for each unit.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.

B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

C. Do not use flanges or unions for underground piping.

D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

E. Underground water-service piping shall be any of the following:

1. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, metal-seated gate valves with valve box.
2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:

   Gate Valves, NPS 2 and Smaller: Bronze, rising stem.

   Gate Valves, NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.

   Check Valves: AWWA C508, swing type.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Section 33 05 00 "Common Work Results for Utilities" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

C. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.

3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.

4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

D. Install PVC, AWWA pipe according to ASTM F645 and AWWA M23.

E. Bury piping with depth of cover over top at least 48 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 60 inches cover over top.

2. In Loose Gravelly Soil and Rock: With at least 48 inches additional cover.

F. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

G. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

H. Sleeves are specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

I. Mechanical sleeve seals are specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

J. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

K. See Section 22 11 16 "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Section 33 05 00 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:

1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D2774 or ASTM D3139 and pipe manufacturer's written instructions.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.

2. Locking mechanical joints.

3. Set-screw mechanical retainer glands.

4. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3.9 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C891.

3.10 PROTECTIVE ENCLOSURE INSTALLATION

A. Install concrete base level and with top approximately 2 inches above grade.

B. Install protective enclosure over valves and equipment.

C. Anchor protective enclosure to concrete base.

3.11 FLUSHING HYDRANT INSTALLATION

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.

B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.

C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.12 CONNECTIONS

A. See Section 33 05 00 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to existing water main. Use service clamp and corporation valve.

C. Connect potable water-distribution piping to interior domestic water piping.

D. Connect raw water-distribution piping to interior fire service piping.

E. Connect waste piping from concrete vault drains to sanitary sewerage system. See Section 22 13 13 "Facility Sanitary Sewers" for connection to sanitary-sewer piping.

F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.13 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints.

Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.14 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 31 20 00 "Earth Moving."

B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 33 05 00 "Common Work Results for Utilities" for identifying devices.

3.15 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

   Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

   Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

   After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

   Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 22 11 13

SECTION 22 13 13

FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. PVC pipe and fittings.
2. Nonpressure-type transition couplings.
3. Pressure-type pipe couplings.
4. Expansion joints and deflection fittings.
5. Backwater valves.
6. Cleanouts.
7. Encasement for piping.
8. Manholes.
9. Concrete.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure and pressure couplings
3. Expansion joints and deflection fittings.
4. Cleanouts.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2. Show system piping in profile. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet and to vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.

B. Product Certificates: For each type of pipe and fitting.

C. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Profile Sewer Piping:

1. Pipe: ASTM F794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

B. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F477, elastomeric seals for gasketed joints.

C. PVC Pressure Piping:

1. Pipe: AWWA C900, Class 150 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 150 PVC pipe with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

D. PVC Water-Service Piping:

1. Pipe: ASTM D1785, Schedule 80 PVC, with plain ends for solvent-cemented joints.
2. Fittings: ASTM D2467, Schedule 80 PVC, socket type.

2.2 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

F. Nonpressure-Type, Rigid Couplings:

1. Description: ASTM C1461, sleeve-type, reducing- or transition-type mechanical coupling; molded from ASTM C1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.3 PRESSURE-TYPE PIPE COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cascade Waterworks Mfg. Co.
2. Dresser, Inc.
3. Jay R. Smith Mfg Co; a division of Morris Group International.
4. Victaulic Company.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.

D. Center-Sleeve Material: Manufacturer's standard.

E. Gasket Material: Natural or synthetic rubber.

F. Metal Component Finish: Corrosion-resistant coating or material.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Medium Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: tube.

D. Color: Black.

2.6 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, FRP ladder, or ASTM A615/A615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch-minimum-width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

C. Manhole-Cover Inserts:

1. Description; Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
2. Type: Solid.

2.7 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
2. Fine Aggregate: ASTM C33/C33M, sand.
3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.

2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: 1 percent through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.

2. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.

3. Install piping with 60-inch minimum cover.

4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install PVC profile sewer piping according to ASTM D2321 and ASTM F1668.
6. Install PVC Type PSM sewer piping according to ASTM D2321 and ASTM F1668.
7. Install PVC gravity sewer piping according to ASTM D2321 and ASTM F1668.

G. Install force-main, pressure piping according to the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 60-inch minimum cover.
3. Install PVC pressure piping according to AWWA M23 or to ASTM D2774 and ASTM F1668.
4. Install PVC water-service piping according to ASTM D2774 and ASTM F1668.

H. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A674 or AWWA C105/A21.5:

1. Expansion joints and deflection fittings.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join PVC profile sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.
2. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
3. Join PVC gravity sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.

B. Join force-main, pressure piping according to the following:

1. Join PVC pressure piping according to AWWA M23 for gasketed joints.
2. Join PVC water-service piping according to ASTM D2855.
3. Join dissimilar pipe materials with pressure-type couplings.

C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    a. Unshielded flexible or rigid couplings for pipes of same or slightly different OD.
    b. Unshielded, increaser/reducer-pattern, flexible or rigid couplings for pipes with different OD.
    c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure pipe couplings for force-main joints.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 BACKWATER VALVE INSTALLATION

A. Install horizontal-type backwater valves in piping manholes or pits.

B. Install combination horizontal and manual gate-type valves in piping and in manholes.

C. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.

2. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

3. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

B. Connect force-main piping to building's sanitary force mains specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Terminate piping where indicated.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe

passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.

a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.9 IDENTIFICATION

A. Comply with requirements in Section 31 20 00 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape or detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.

2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.

c. Damage: Crushed, broken, cracked, or otherwise damaged piping.

d. Infiltration: Water leakage into piping.

e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.

4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.

4. Submit separate report for each test.

5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.

b. Close openings in system and fill with water.

c. Purge air and refill with water.

d. Disconnect water supply.

e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Test plastic gravity sewer piping according to ASTM F1417.

b. Test concrete gravity sewer piping according to ASTM C1628.

7. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig.

a. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

8. Manholes: Perform hydraulic test according to ASTM C969.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 22 13 13

SECTION 22 13 29

SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Submersible sewage pumps.
3. Wet-pit-volute sewage pumps.
4. Sewage-pump, reverse-flow assemblies.
5. Sewage-pump basins and basin covers.
6. Progressing-cavity sewage pumps.
7. Packaged, submersible sewage-pump units.
8. Packaged wastewater-pump units.

B. Related Requirements:

1. Section 22 13 43 "Facility Packaged Sewage Pumping Stations" for applications in site-construction sewage pumping.
2. Section 22 14 29 "Sump Pumps" for applications in storm-drainage systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.2 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Quick-Disconnect, Grinder Sewage Pumps:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   EBARA Fluid Handling.

   HOMA Pump Technology Inc.

2. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
5. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

   Motor Housing Fluid: Air.

9. Controls:

   Enclosure: NEMA 250, Type 4X.

   Switch Type: Pedestal-mounted float switch with float rods and rod buttons.

Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.

High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

10. Controls:

Enclosure: NEMA 250, Type 4X; wall mounted.

Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

Remote Alarm Contacts: For remote alarm interface.

Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.

2) Alarm status.

12. Guide-Rail Supports:

Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."

Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.

Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.

Pump Yoke: Motor- or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.

Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.

Lifting Cable: Stainless steel; attached to pump and cover at manhole.

B. Capacities and Characteristics:

1. Unit Capacity: 200 gpm.

2. Number of Pumps: Two.

3. Each Pump:

Capacity: 200 gpm.

Solids Handling Capability: 2 inches minimum.

Total Dynamic Head: 28 feet.

Speed: Per Manufacturer.

Discharge Pipe Size: 4 NPS.

Motor Horsepower: 3 hp.

Electrical Characteristics:

1) Volts: 480 V ac.

2) Phases: Three.

3) Hertz: 60.

4. Unit Electrical Characteristics:

Full-Load Amperes: 4.3 A.

Minimum Circuit Ampacity: Per Vendor Recommendations.

Maximum Overcurrent Protection: Per Vendor Recommendations.

2.3 SEWAGE-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Cast iron.
2. Reinforcement: Mounting plates for pumps, fittings, guide-rail supports if used, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: 2300 gal..
2. Diameter: 84 inches.
3. Depth: 72 inches.
4. Inlet No. 1:

   Drainage Pipe Size: 8 NPS.

   Bottom of Sump to Centerline: 80 inches.

   Type: Hubbed outside.
5. Inlet No. 2:

   Drainage Pipe Size: 8 NPS.

   Bottom of Sump to Centerline: 80 inches.

   Type: Hubbed outside.
6. Cover Material: Cast iron.
7. Cover Diameter: 48 inches, but not less than outside diameter of basin top flange.
8. Manhole Required in Cover: Yes.
9. Vent Size: 4 NPS.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.

2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3. Comply with requirements for vibration isolation devices specified in Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 13 29

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sidewall propeller fans.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions and horsepower indicated.
4. Certified fan sound-power ratings.
5. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance
6. Motor ratings and electrical characteristics, plus motor and electrical accessories.
7. Dampers, including housings, linkages, and operators.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams

PART 2 - PRODUCTS

2.1 SIDEWALL PROPELLER FANS

A. Housing: Galvanized-steel sheet, with baked-enamel finish coat applied after assembly.

B. Fan Wheel:

1. Replaceable, aluminum, blades fastened to steel hub; factory set pitch angle of blades.
2. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).

C. Fan Drive: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Motors

1. Motor enclosure: TEFC

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

3. Accessible for maintenance

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit, NEMA 1 enclosure.

2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.

3. Motor-Side Back Guard: Protective guards of welded steel wire completely enclose the motor and drive side of the fan, removable for maintenance.

4. Wall Collar: Galvanized steel to match fan and accessory size.

5. Weather Hood: Galvanized steel to match fan and accessory size, 45 degree turndown angle, ½” x ½” welded wire birdscreen.

2.2 SOURCE QUALITY CONTROL

A. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

B. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

C. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

D. Statically and dynamically balanced in accordance with AMCA Standard 204-05

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories

G. UL Standards: Power ventilators shall comply with UL 705.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

A. Install power ventilators level and plumb.

B. Equipment Mounting: Wall collar mounting in accordance with manufacturer’s instructions and the drawings.

C. Install units with clearances for service and maintenance.

D. Install fans as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings

E. Install fans in accordance with manufacturer's instructions

3.2 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Energize motor and measure and record motor voltage and amperage.
9. Other startup testing in accordance with IOM manual.
10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 82 39.19

WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes wall heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall heaters to include in installation, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, wall bracket, and controls.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CABINET

A. Cabinet: Steel, minimum 18-gauge thickness with removable panels for maintenance access and adjustable louvers.

B. Finish: Powder coated, epoxy coated, or baked enamel over baked-on primer with manufacturer's standard color, applied to factory-assembled and -tested wall heaters before shipping.

2.3 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection.

2.4 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: TEFC rated for continuous duty. Built-in thermal cutout.

2.5 CONTROLS

A. Controls: Remote mounted thermostat.

B. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall unit heaters to comply with NFPA 90A.

B. Install wall unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 23 82 39.19

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.

B. NETA ATS: Acceptance Testing Specification.

C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch lengths for each type of cable specified.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Qualification Data: For Installer.

C. Material Certificates: For each type of cable and accessory.

D. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

E. Source quality-control reports.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Comply with IEEE C2 and NFPA 70.

B. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. The cables specified on Drawings as 15 kV shall be single-conductor, shielded, solid-dielectric type rated for 105°C normal operation. The cables shall be listed by UL as Type MV-150 and have a 15,000-V rating. All cables shall be “sunlight resistant.”.

B. The conductor shall be stranded copper, sized in accordance with the drawings. The insulation level shall be 133% of rated voltage with a minimum thickness of 220 mils per requirements of ICEA S-68-516, UL 1072, and AEIC C56.

C. The cables shall conform to the following:

1. Cables shall be suitable for use in wet and dry locations, underground duct systems.
2. Conductors shall be Class B Compact Copper, per ICEA S-68-516, Part 2 and UL 1072.
3. Each conductor shall be covered with an extruded semi-conducting polymeric material applied over the surface of the conductor that is compatible with the insulation.
4. The insulation applied over the extruded strand screen shall be high-quality ethylene propylene blended and compounded within the cable manufacturer’s facilities under optimum conditions of cleanliness.
5. The type of insulation shielding – copper tape shielding: each conductor shall have a bare 5-mil minimum thick copper shielding tape helically applied over the insulation shield with a minimum 25% overlap of the tape width.
6. Wire pulling compound: Electro Compound Company “Y-er Eas,” or American Polywater Corporation “Polywater.”

2.3 CONNECTORS

A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

B. Copper-Conductor Connectors: Copper barrel crimped or Aluminum barrel crimped connectors.

C. Provide Load Break Elbows complete with inserts, on the transformer primary connection: 15 kV, 200A load break connector, Cooper 500-10 series. Provide feed thru load breaks where required to extend primary circuits.

D. Lightning arrestors for transformer: Metal oxide, elbow shaped, with metal oxide varistor, rated at 18 kV (15.3 MCOV), in premolded insulating elbow designed for use with the RTE 200 A 8.3/14.4 kV loadbreak bushings that are on the transformer.

2.4 SPLICE KITS

A. Description: For connecting medium voltage cables; type as recommended by cable or splicing kit manufacturer for the application.

B. Standard: Comply with IEEE 404.

C. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

2.5 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.

C. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches (38 mm) wide.

D. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.6 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

C. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

D. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.

I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of 1-inch-wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

L. Install fault indicators on each phase where indicated.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Ground shields of shielded cable at one point only. Maintain shield continuity and connections to metal connection hardware at all connection points.

3.2 FIELD QUALITY CONTROL

A. Perform testing in accordance with Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION 26 05 13

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Armored cable, Type AC, rated 600 V or less.
4. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:

1. Type USE-2 and Type SE: Comply with UL 854.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors with an equipment grounding conductor in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multi-circuit with color-coded conductors where indicated on the Drawings.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

G. Armor: Aluminum, interlocked.

H. Jacket: PVC applied over armor.

2.3 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with an equipment grounding conductor in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors where indicated on the Drawings.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

G. Armor: Aluminum, interlocked.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper or Aluminum.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Install conductors in accordance with NEC wiring methods and as shown on the Drawings.

B. Install conductor insulation types and sizes as shown on the Drawings.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 FIELD QUALITY CONTROL

A. Perform testing in accordance with Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Concrete encased grounding electrodes.
2. Ground rods
3. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 GENERAL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar or compression type, copper or copper alloy, with two wire terminals.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

I. Water Pipe Clamps:

1. U-bolt type with malleable-iron clamp and copper ground connector.

2.4 GROUNDING ELECTRODES

A. Concrete encased ground electrode: Install concrete encased electrode as shown on the Drawings.

B. Ground Rods: Install ground rods as shown on the drawings.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Ground Conductors: Install solid conductor for #8 AWG and smaller, and stranded conductors for #6 AWG and larger unless otherwise indicated.

B. Grounding Conductors: Solid green-colored insulation or green colored with continuous yellow stripe.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated on the Drawings.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Structural Steel: Bolted or compression connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses at the service disconnect.

B. Extend grounding electrode conductor from service disconnect to ground electrode via main ground bar as shown on the drawings.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Ground separately derived systems in accordance with the NEC and as shown on the drawings.

B. Bond neutral and ground bar at first disconnect downstream of separately derived system. Extend grounding electrode conductor to ground electrode.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

C. Metallic Fences: Comply with requirements of IEEE C2 where fencing is located within the minimum distance wherein grounding is required.

1. Grounding Conductor: Bare copper, not less than 6 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.

3.5 FENCE GROUNDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

    a. Gates and Other Fence Openings: Ground fence on each side of opening.

        1) Bond metal gates to gate posts.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

3.6 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70;

1. Use a minimum of 20 feet of bare copper conductor not smaller than #4 AWG as shown on the Drawings OR use electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Perform testing in accordance with Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
   a. Slotted support systems, hardware, and accessories.
   b. Clamps.
   c. Hangers.
   d. Sockets.
   e. Eye nuts.
   f. Fasteners.
   g. Anchors.
   h. Saddles.
   i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.

1.5 QUALITY ASSURANCE

1. None.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
5. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101

B. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. RMC: Rigid Metal Conduit

C. IMC: Intermediate metal conduit.

D. PVC: Polyvinyl chloride

E. EMT: Electrical Metal Tubing

F. FMC: Flexible Metal Conduit

G. LFMC: Liquid-tight Flexible Metal Conduit

H. ENT: Electrical Non-metallic Tubing

I. RNC: Rigid Non-metallic Conduit

J. LFNC: Liquid-tight Flexible Non-metallic Conduit

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. GRC: Comply with ANSI C80.1 and UL 6.
3. IMC: Comply with ANSI C80.6 and UL 1242.
4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch, minimum.
5. EMT: Comply with ANSI C80.3 and UL 797.
6. FMC: Comply with UL 1; zinc-coated steel.
7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC and GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. ENT: Comply with NEMA TC 13 and UL 1653.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
    a. Fittings for LFNC: Comply with UL 514B.
3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated on the Drawings, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type or Screw-cover type unless otherwise indicated on the Drawings.

D. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

J. Cabinets:

1. NEMA 250, Type 1 for indoor and Type 3R for outdoor, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Boxes and handholes as indicated on the Drawings.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC, IMC
2. Concealed Conduit, Aboveground: GRC, IMC, EMT.
3. Underground Conduit: GRC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

M. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg Ftemperature change.
    d. Attics: 135 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

AA. Mount boxes at heights indicated on Drawings.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

CC. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

DD. Locate boxes so that cover or plate will not span different building finishes.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
   b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, 18” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For arc-flash hazard study, see CHPRC-03960, Integrated Disposal Facility Electrical Distribution System Study, for Arc Flash labels.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage (480/277, 208/120, 240/120).

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
2. Colors for 208/120-V Circuits:
    a. Phase A: Black.
    b. Phase B: Purple.
    c. Phase C: Brown.
3. Colors for 240-V Circuits:
    a. Phase A: Black.
    b. Phase B: Brown.
4. Colors for 480/277-V Circuits:
    a. Phase A: Red.
    b. Phase B: Yellow.
    c. Phase C: Blue.
5. Color for Neutral: White or gray.
6. Color for Equipment Grounds: Green or Green with a yellow stripe.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. Working Distances on label shall be 36”, 42” or 48” as required by the NEC.

F. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Labels Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.

b. 3-1/2 by 5 inches for equipment.

c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

D. Underground-Line Warning Tape:

1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

b. Printing on tape shall be permanent and shall not be damaged by burial operations.

c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.

b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".

c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

    1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

    1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

K. Vinyl Wraparound Labels:

    1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

    2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

L. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

N. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

O. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

U. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase.

D. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

E. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

F. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.

2. For equipment with multiple power or control sources, apply to door or cover of equipment.

H. Arc Flash Warning Labeling: Self-adhesive labels. Reference calculation CHPRC-03960, Integrated Disposal Facility Electrical Distribution System Study, for Arc Flash labels.

I. Panelboards: Provide final as-built circuit configuration as shown on panel schedule drawings. Reference drawing that has specific panel schedule information.

END OF SECTION 26 05 53

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section covers the Work necessary to commission the electrical system. Work in this Section is the responsibility of the Contractor and the qualified testing firm.

B. Section includes Cx process requirements for the following electrical components, systems, assemblies, and equipment:

1. Electrical equipment including the following:
    a. Primary and secondary service electrical systems.
    b. Distribution and branch-circuit panelboards.
    c. Grounding systems.
2. Controls and instrumentation, including the following:
    a. Lighting control systems.

1.3 DEFINITIONS

A. BoD: Basis-of-Design Document, as defined in Section 01 91 13 "General Commissioning Requirements."

B. Cx: Commissioning

C. CxA: Commissioning Authority

D. Low Voltage: 600 V and below.

E. Medium Voltage: 601 V and above.

F. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing technician.

B. Construction Checklists: Draft construction checklists will be created by CxA for Contractor review.

C. Construction Checklists: Include the following equipment:

1. Control for lighting control systems.
2. Low-voltage power cables.
3. Electrical feeders and branch circuits.
4. Dry-type transformers.

5. Medium-voltage power cables.
6. Molded-case circuit breakers.
7. Grounding systems.
8. Panelboards.
9. Receptacles and devices.
10. Lighting.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electrical systems and components to include in operation and maintenance manuals.

B. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test, including construction acceptance testing and factory acceptance testing.

1.6 QUALITY ASSURANCE

A. Electrical Testing Technician Qualifications: Technicians to perform electrical Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in electrical systems, or similar field. Degree may be offset by three years' experience as an apprentice or a journey-level electrician. Generally, required knowledge includes electrical and HVAC&R concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform electrical Cx work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:
   a. Equipment/instrument identification number.
   b. Planned Cx application or use.
   c. Manufacturer, make, model, and serial number.
   d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
2. Test equipment and instrumentation shall meet the following criteria:
   a. Capable of testing and measuring performance within the specified acceptance criteria.
   b. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
   c. Be maintained in good repair and operating condition throughout duration of use on Project.
   d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. Prepare detailed construction checklists for electrical systems, subsystems, equipment, and components. Complete and submit construction checklists.

3.2 CONSTRUCTION CHECKLIST REVIEW

A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor. Checklist will be developed based on testing requirements provided in Section 3.4 through 3.6 of this specification.

B. Return draft Construction Checklist review comments within 10 days of receipt.

C. When review comments have been resolved, CxA will provide final construction checklists, marked "Approved for Use, (date)."

D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 GENERAL Cx REQUIREMENTS

A. Certify that electrical systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Construction Checklists: Prepare and submit detailed construction checklists for electrical systems, subsystems, equipment, and components.

   1. Contributors to development of construction checklists shall include, but are not limited to, the following:

      a. Electrical systems and equipment installers.

      b. Electrical instrumentation and controls installers.

C. Perform tests using design conditions, whenever possible.

D. If tests cannot be completed because of a deficiency outside the scope of the electrical system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

E. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

F. Coordinate schedule with and perform Cx activities at the direction of the CxA.

G. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Sections specifying electrical systems and equipment.

H. Provide technicians, instrumentation, tools, and equipment to complete and document the commissioning tests.

3.4 GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

A. Tests and inspections shall establish:

   1. Electrical equipment is operational within industry and manufacturer’s tolerances and standards.

   2. Installation operates properly.

3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and IEEE C2, NFPA 70, and NFPA 70E.

B. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer’s recommendations.

C. Adjust mechanisms and moving parts of equipment for free mechanical movement.

D. Verify nameplate data for conformance to Contract Documents and approved Submittals.

E. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screwdriver to manufacturer’s recommendations, or as otherwise specified in NETA ATS.

F. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

G. Provide proper lubrication of applicable moving parts.

H. Inform CHPRC Field Engineer of working clearances not in accordance with NFPA 70.

I. Investigate and repair or replace:
1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer’s instructions.
3. Damaged electrical equipment.

J. Electrical Enclosures:
1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by CHPRC Field Engineer, door and panel sections having dented surfaces.
5. Repair or replace, as determined by CHPRC Field Engineer, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required due to extensive damage, as determined by CHPRC Field Engineer, refinish entire assembly.

K. Identify and inform CHPRC Field Engineer of fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.5 EQUIPMENT SPECIFIC TESTING REQUIREMENTS

A. CHECKOUT AND STARTUP
1. Voltage Field Test:
   a. Check voltage at point of supply system to project when installation is essentially complete and is in operation.
2. Equipment Line Current Tests:
   a. Check line current in each phase for each panelboard.

b. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

B. DRY TYPE Transformers

1. Perform the following visual and mechanical checks below.

a. Visually inspect the transformer for physical damage. Repair any physical damage, if possible, and provide suitable protective barriers to prevent future damage.

b. Compare the transformer nameplate information with the drawings and/or specifications for the installation.

c. Verify proper connection of the taps in accordance with the nameplate information.

d. Check the clearance of all electrical connections. Verify all connections for tightness with a calibrated torque wrench.

e. Visually check the core, frame, enclosure, conduits, raceways and conductors for proper ground bonding.

2. Perform Electrical tests on transformer in accordance with manufacturer's instructions.

C. PANELBOARDS

1. Visual and Mechanical Inspection: Include the following inspections and related work:

a. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

b. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.

c. Check panelboard mounting, area clearances, and alignment and fit of components.

d. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

e. Perform visual and mechanical inspection for overcurrent protective devices.

2. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

a. Ground continuity test ground bus to system ground.

D. LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

1. Visual and Mechanical Inspection:

a. Inspect each individual exposed power conductor for:

b. Physical damage.

c. Proper connections in accordance with single-line diagram.

d. Cable bends not in conformance with manufacturer's minimum allowable bending radius.

e. Color coding conformance with Specifications.

f. Proper circuit identification.

2. Mechanical Connections for:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.

3. Electrical Tests for Power and Lighting Conductors No. 4 and Larger:

a. Insulation Resistance Tests:

1) Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.

2) Test each conductor with respect to ground and to adjacent conductors for one minute.

3) Evaluate ohmic values by comparison with conductors of same length and type.

4) Investigate values less than 50 megohms. Make repairs as necessary until measured value is less than 50 megohms.

4. Continuity test by ohmmeter method to ensure proper cable connections and test for unintentional connection to ground.

5. Electrical Tests for Power and Lighting Conductors No. 6 and Smaller:

a. As minimum, installation and testing shall include the following:

1) Continuity test by ohmmeter method to ensure proper cable connections and test for unintentional connection to ground.

6. Record all results and include on final report.

E. SAFETY SWITCHES, 600 VOLTS MAXIMUM

1. Visual and Mechanical Inspection:

a. Proper blade alignment.

b. Proper operation of switch operating handle.

c. Adequate mechanical support for each fuse.

d. Proper contact-to-contact tightness between fuse clip and fuse.

e. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.

f. Manufacturer’s phase barrier material installed and in place.

g. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.

h. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

2. Electrical Tests:

a. Insulation Resistance Tests:

1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

2) Phase-to-phase and phase-to-ground for one minute on each pole.

3) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

b. Contact Resistance Tests:

1) Contact resistance in microhms across each switch blade and fuse holder.

2) Investigate deviation of 50 percent or more from adjacent poles or similar switches.

F. MOLDED AND INSULATED CASE CIRCUIT BREAKERS

1. General: Inspection for all circuit breakers.
2. Visual and Mechanical Inspection:
   a. Proper mounting.
   b. Proper conductor size.
   c. Feeder designation according to nameplate and one-line diagram.
   d. Cracked casings.
   e. Connection bolt torque level in accordance with NETA ATS,Table 100.12.
   f. Operate breaker to verify smooth operation.
   g. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
   h. Verify that terminals are suitable for 75°C rated insulated conductors.

G. GROUNDING SYSTEMS

1. Visual and Mechanical Inspection:
   a. Equipment and circuit grounds in panelboard for proper connection and tightness.
   b. Ground bus connections in panelboard for proper termination and tightness.
   c. Effective dry-type transformer equipment grounding.
   d. Accessible connections to grounding electrodes for proper fit and tightness.
   e. Accessible compression connections grounding connections to verify that proper bonding was obtained.
2. Electrical Tests:
   a. Perform the following tests and inspections after installing grounding system but before permanent electrical circuits have been energized to test for compliance with requirements.
   b. Inspect physical and mechanical condition and verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
      1) Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at before any conductors are connected.
      2) Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      3) Perform tests by fall-of-potential method according to IEEE 81.
   c. Grounding system will be considered defective if it does not pass tests and inspections
   d. Two-Point Direct Method Test:
      1) In accordance with IEEE 81, Section 8.2.1.1, for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.

2) Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

e. Neutral Bus Isolation:

1) Test each neutral bus individually with neutral bonding jumper removed at separately derived system.

2) Evaluate ohmic values by measuring resistance between ground bus and neutral bus.

3) Investigate values less than 50 megohms.

H. LIGHTING CONTROLS

1. Perform the following tests and inspections for roadway, parking area, and building exterior lighting systems:

a. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

b. Test and adjust controls (if applicable). Replace damaged and malfunctioning controls and equipment.

2. Lighting control devices will be considered defective if they do not pass tests and inspections.

I. WIRING DEVICES

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

3. Perform the following tests and inspections:

a. Tests for Receptacles:

1) Line Voltage: Acceptable range is 105 to 132 V.

2) Ground Impedance: Values of up to 2 ohms are acceptable.

3) GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

4) Using the test plug, verify that the device and its outlet box are securely mounted.

5) Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions by removing malfunctioning units and replacing with new ones, and retest as specified above.

4. Wiring device will be considered defective if it does not pass tests and inspections.

J. MEDIUM VOLTAGE CABLES

1. Perform the following tests and inspections:

a. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

b. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements in NETA ATS.

1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

2) Perform insulation resistance test for each conductor and between conductors and shields.

3) Perform shield continuity test on each power cable.

4) Perform other electrical tests as required per NETA ATS Section 7.3.3.

2. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 08 00

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Photoelectric switches.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    a. Faulty operation of lighting control devices.
    b. Verify available warranties and warranty periods for lighting control devices.
2. Warranty Period: Two year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Description: As indicated on the Drawings.

1. Listed and labeled as defined in NFPA 70, by an agency NRTL, and marked for intended location and application.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

A. Description: As indicated on the Drawings.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is ¾ inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform acceptance testing in accordance with Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION 26 09 23

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 15 and 20 A.
2. GFCI receptacles, 125 V, 15 and 20 A.
3. Toggle switches, 120/277 V, 15 and 20 A.
4. Wall plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

F. Wall Plate Color: For plastic covers, match device color.

G. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 15 A

A. Duplex Receptacles, 125 V, 15 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 15 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.4 GFCI RECEPTACLES, 125 V, 15 and 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-15R and 5-20R.
3. Type: Feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.5 TOGGLE SWITCHES, 120/277 V, 15 A

A. Single-Pole Switches, 120/277 V, 15 A:

1. Standards: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 15 A:

1. Standards: Comply with UL 20 and FS W-S-896.

C. Four-Way Switches, 120/277 V, 15 A:

1. Standards: Comply with UL 20 and FS W-S-896.

2.6 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:

1. Standards: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 20 A:

1. Standards: Comply with UL 20 and FS W-S-896.

C. Four-Way Switches, 120/277 V, 20 A:

1. Standards: Comply with UL 20 and FS W-S-896.

2.7 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant**,** die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated on the drawings.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes.

2. Keep outlet boxes free of dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install wiring devices after all wall preparation, including painting, is complete, where applicable.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until just prior to installation.
4. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
5. Use a torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on the device.
8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform acceptance testing in accordance with Section 26 08 00, Commissioning of Electrical Systems.

END OF SECTION 26 27 26

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. Bonding conductor for telecommunications (BCT), telecommunications main grounding busbar (TMGB), telecommunications grounding busbars (TGBs), and routing of their bonding conductors.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer should have personnel certified by BICSI on staff.

1. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection as required.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Harger Lightning & Grounding.
2. Panduit Corp.
3. TE Connectivity Ltd.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 8 AWG.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Harger Lightning & Grounding.
3. Panduit Corp.
4. TE Connectivity Ltd.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Chatsworth Products, Inc.
2. Harger Lightning & Grounding.
3. Panduit Corp.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

A. Comply with requirements for identification products in Section 27 05 53 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

   1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

   2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

   3. Connections to Ground Rods at Test Wells (if installed): Bolted connectors.

   4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

   1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

   1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.

   2. Install without splices.

   3. Support at not more than 36-inch intervals.

   4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

      a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.

3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

   a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

   a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 27 05 26

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Hooks.
9. Boxes, enclosures, and cabinets.
10. Polymer-concrete handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product data for each type of product.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale and coordinated with each other, using input from installers of items involved.

B. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Allied Tube & Conduit; a part of Atkore International.
2. O-Z/Gedney; a brand of Emerson Industrial Automation.
3. Thomas & Betts Corporation; A Member of the ABB Group.
4. Western Tube and Conduit Corporation.

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2. Comply with TIA-569-D.

D. GRC: Comply with ANSI C80.1 and UL 6.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:
   a. Material: Steel or die cast.
   b. Type: Setscrew or compression.
2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Allied Tube & Conduit; a part of Atkore International.
2. CANTEX INC.
3. Carlon; a brand of Thomas & Betts Corporation.
4. RACO; Hubbell.
5. Thomas & Betts Corporation; A Member of the ABB Group.

C. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Rigid HDPE: Comply with UL 651A.

F. Continuous HDPE: Comply with UL 651A.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

1. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum or general-use installation unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Alpha Wire.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Endot Industries Inc.
4. IPEX USA LLC.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. B-line, an Eaton business.
2. Hoffman; a brand of nVent.
3. Square D; by Schneider Electric.

C. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 12 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Allied Moulded Products, Inc.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Hoffman; a brand of nVent.

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MonoSystems, Inc.
2. Panduit Corp.
3. Wiremold / Legrand.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.7 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carlon; a brand of Thomas & Betts Corporation.
2. Panduit Corp.
3. Quazite: Hubbell Power Systems, Inc.
4. Wiremold / Legrand.

C. Finish: Texture and color selected by Architect from manufacturer's standard colors.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.8 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized steel.

2.9 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Carlon; a brand of Thomas & Betts Corporation.
2. Hoffman; a brand of nVent.
3. RACO; Hubbell.
4. Thomas & Betts Corporation; A Member of the ABB Group.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep minimum.

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Shape: Rectangular.
3. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:
    a. Material: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.10 POLYMER-CONCRETE HANDHOLES

A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Oldcastle Precast, Inc.

2. Quazite: Hubbell Power Systems, Inc.

C. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

3. Comply with TIA-569-D and SCTE 77.

D. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

2. Cover Legend: Molded lettering, "COMMUNICATIONS".

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

B. Pathway Fittings: Compatible with pathways and suitable for use and location.

C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

D. Install surface pathways only where indicated on Drawings.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.

2. NECA/BICSI 568.

3. TIA-569-D.

4. NECA 101

5. NECA 102.

6. NECA 105.

7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

E. Complete pathway installation before starting conductor installation.

F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.

2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.

3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.

4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

N. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

O. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

P. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

2. Install surface pathway with a minimum 2-inch radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

Q. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.

3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

S. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

W. Mount boxes at heights indicated on Drawings. Install boxes with height measured to top of box unless otherwise indicated.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Install backfill.
2. After installing conduit, backfill and compact.
3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
4. Underground Warning Tape: Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 27 05 28

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible labels with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

2. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

2.4 SIGNS

A. Laminated-Acrylic or Melamine-Plastic Signs:

1. Engraved legend.
2. Thickness:
   a. For signs up to 20 sq. in., minimum 1/16 inch thick.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Self-adhesive.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Verify identity of each item before installing identification products.

C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

D. Apply identification devices to surfaces that require finish after completing finish work.

E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

G. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

H. Snap-Around Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

I. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:
    a. Telecommunications.

D. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

E. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:

   1. Room number.

   2. Colon.

   3. Faceplate number.

F. Instructional Signs: Self-adhesive labels.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.

   1. Apply to exterior of door, cover, or other access.

H. Equipment Identification Labels:

   1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.

   2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.

   3. Equipment to Be Labeled:

      a. Communications cabinets.

END OF SECTION 27 05 53

SECTION 27 11 16

COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 19-inch freestanding equipment cabinets.
3. Power strips.
4. Grounding.
5. Labeling.

1.2 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer should have personnel certified by BICSI on staff.

1. Field Inspector: Currently registered by BICSI as Technician to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 19-INCH EQUIPMENT RACKS

A. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Bud Industries, Inc.
2. Dell Inc.
3. Emerson Network Power Connectivity Solutions.
4. Hammond Mfg. Co. Inc.

C. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:

1. Overall Height: 72 inches or as indicated on Drawings.
2. Overall Depth: 23 inches.
3. Upright Depth: 3 inches
4. Two-Post Load Rating: 200 lb.
5. Number of Rack Units per Rack: 38 or as indicated on Drawings.
   a. Numbering: Every five rack units, on interior of rack.
6. Threads: 10-32.
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 19-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Bud Industries, Inc.
2. Dell Inc.
3. Emerson Network Power Connectivity Solutions.
4. Hammond Mfg. Co. Inc.

C. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Modular Freestanding Cabinets:

1. Overall Height: 72 inches or as indicated on Drawings.
2. Overall Depth: 23 inches.
3. Load Rating: 3000 lb.
4. Number of Rack Units: 38 or as indicated on Drawings.
    a. Numbering: Every five rack units, on interior of rack.
5. Threads: 10-32.
6. Removable and lockable side and top panels.
7. Hinged and lockable front and rear doors.
8. Adjustable feet for leveling.
9. Screened ventilation openings in roof and rear door.
10. Cable access provisions in roof and base.
11. TGB.
12. Rack-mounted, 550-cfm fan with filter.
13. Power strip.
14. All cabinets keyed alike.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, with detachable flanges.
3. Height: 1 RU.
4. Housing: Metal.
5. Six, 15-A, 120 VAC, NEMA WD 6, Configuration 5-15R receptacles.
6. Front-facing receptacles.
7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Close-coupled, direct plug-in line cord.
12. Rocker-type on-off switch, illuminated when in on position.
13. Surge Protection: UL 1449, Type 3.
    a. Maximum Surge Current, Line to Neutral: 27 kA.
    b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
    c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V] and 500 V for neutral to ground.

2.5 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.
2. Harger Lightning & Grounding.
3. Panduit Corp.

C. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.6 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection".

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 05 53 "Identification for Electrical Systems."

B. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

D. Labels shall be machine printed. Type shall be 3/16 inch in height minimum.

END OF SECTION 27 11 16

SECTION 27 13 13

COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Category 6a twisted pair cable.
3. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
4. Grounding provisions for twisted pair cable.
5. Cabling identification products.
6. Source quality control requirements for twisted pair cable.

B. Related Requirements:

1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for data cabling associated with system panels and devices.

1.2 COPPER BACKBONE CABLING DESCRIPTION

A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Product Certificates: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer should have personnel certified by BICSI on staff.

B. Testing Agency Qualifications: Testing agency should have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
2. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: 100-ohm, 23 AWG, four unshielded twisted pairs (UTP), riser-rated cable, with internal spline, covered with a blue thermoplastic jacket.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. General Cable; General Cable Corporation.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

2.4 TWISTED PAIR CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware:

1. Twisted pair cable hardware shall meet the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.

3. Cables shall be terminated with connecting hardware of same category or higher.

B. Plugs and Plug Assemblies:

1. Male; eight position (8P8C); color coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

C. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

D. Faceplates:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work-area cords.
   a. Flush-mount jacks, positioning the cord at a 45-degree angle.

E. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.6 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings."

B. Comply with Section 27 05 28 "Pathways for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.4 INSTALLATION OF COPPER BACKBONE CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Manual," Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI's "Information Transport Systems Installation Manual," Ch. 6, "Cable Termination Practices." Use lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI's "Information Transport Systems Installation Manual," Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

C. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 13 13

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 5e twisted pair cable.
2. Category 6 twisted pair cable.
3. Category 6a twisted pair cable.
4. Twisted pair cable hardware, including plugs and jacks.
5. Cable management system.
6. Grounding provisions for twisted pair cable.

1.2 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer should have personnel certified by BICSI on staff.

1. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency should have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway.
2. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 5e TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden Inc.
3. General Cable; General Cable Corporation.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

D. Conductors: 100-ohm, 24 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Riser.

G. Jacket: White thermoplastic.

2.4 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. General Cable; General Cable Corporation.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Riser.

G. Jacket: Blue thermoplastic.

2.5 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. General Cable; General Cable Corporation.

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Riser.

G. Jacket: Blue thermoplastic.

2.6 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Standard: Comply with TIA-568-C.2.

D. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.

2. Designed to snap-in to a patch panel or faceplate.

3. Standard: Comply with TIA-568-C.2.

4. Marked to indicate transmission performance.

E. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.

2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."

3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

F. Legend:

1. Machine printed, in the field, using adhesive-tape label.

2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

PART 3 - EXECUTION

3.1 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

D. General Requirements for Cabling:

1. Comply with TIA-568-C.1.

2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.2 FIRESTOPPING

A. Comply with TIA-569-D, Annex A, "Firestopping."

B. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

B. Equipment grounding conductors.

C. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

   b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

D. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 27 15 13

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 CRITERIA FOR BIDDING

A. Base bids on the following criteria:

1. Surface elevations are as indicated.
2. Pipes or other artificial obstructions, except those indicated, will not be encountered.
3. Ground water should not be encountered.
4. Material character to be consistent.

1.2 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. AASHTO T 180, “(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in) Drop”
2. AASHTO T 224, “(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test”
3. AWWA C600, “(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances”
4. ASTM C 136, “(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates”
5. ASTM D 1140, “(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve”
6. ASTM D 1556, “(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method”
7. ASTM D 1557, “(2007) Standard Test Methods for Laboratory Compaction characteristics of Soil Using Modified Effort (56,000ft-lbf/ft^3) (2700 kN-m/m^3)”
8. ASTM D 2167, “(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method”
9. ASTM D 2487, “(2006e1) Soils for Engineering Purposes (Unified Soil Classification System)”
10. ASTM D 422, “(1963; R 2007) Particle-Size Analysis of Soils”
11. ASTM D 4318, “(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
12. ASTM D 6938, “(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)”

1.3 DEFINITIONS

A. Satisfactory Materials

1. Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, SW, SP. Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements and railroads which comprise stones less than 2 inches in any dimension.

B. Unsatisfactory Materials

1. Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

C. Cohesionless and Cohesive Materials

1. Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are non-plastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

D. Degree of Compaction

1. Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4-inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

E. Topsoil

1. Material suitable for topsoil's obtained from offsite areas is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one-inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

F. Hard/Unyielding Materials

1. Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 3 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

G. Rock

1. Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

H. Unstable Material

1. Unstable material too wet to properly support the utility pipe, conduit, or appurtenant structure.

I. Select Granular Material

1. General Requirements

a. Select granular material consist of materials classified as GW,GP,SW,SP,by ASTM D 2487 where indicated. The liquid limit of such material must not exceed

35 percent when tested in accordance with ASTM D 4318. The plasticity index must not be greater than 12 percent when tested in accordance with ASTM D 4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D 1140.

J. Initial Backfill Material

1. Initial backfill consists of select granular material 2 inches or smaller or satisfactory on-site materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfills material of stones larger than 2 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.4 SYSTEM DESCRIPTION

A. Subsurface soil boring logs do not currently exist for the area of construction

B. Classification of Excavation

1. All excavated material shall be considered as unclassified regardless of materials encountered.

1.5 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. Testing
2. An approved DOE validated testing laboratory shall be used for testing facilities.

PART 2 - PRODUCTS

2.1 BURIED WARNING AND IDENTIFICATION TAPE

A. Provide polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3-inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric
Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air
Purple:	Leachate Systems

B. Warning Tape for Metallic Piping

1. Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a

minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

C. Detectable Warning Tape for Non-Metallic Piping

1. Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.2 DETECTION WIRE FOR NON-METALLIC PIPING

A. Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

PART 3 - EXECUTION

3.1 STRIPPING OF TOPSOIL

A. Where indicated or directed, strip topsoil to a depth of 4 inch. Spread topsoil on areas already graded and prepared for topsoil or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 1 inch in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and grading.

3.2 GENERAL EXCAVATION

A. Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Disposal of all unused excavation material shall be off the base facility.

B. Ditches, Gutters, and Channel Changes

C. Drainage Structures

1. Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete is to be placed.

D. Drainage

1. Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features

develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

E. Trench Excavation Requirements

1. Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended in the manufacturer's printed installation manual Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than 4 feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than 4 feet high. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inch inside diameter, and do not exceed 36 inch plus pipe outside diameter for sizes larger than 24 inch inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

2. Bottom Preparation

   a. Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 2 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3. Removal of Unyielding Material

   a. Where unyielding material is encountered in the bottom of the trench, remove such material below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

4. Removal of Unstable Material

   a. Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

5. Excavation for Appurtenances

   a. Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inch clear between the outer structure surfaces and the face of the excavation or support members. Clean rock of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

F. Underground Utilities

1. The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. For work

immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

G. Structural Excavation

1. Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Backfill and compact over excavations and changes in grade to 95 percent of ASTM D 1557 maximum density.

3.3 SELECTION OF BORROW MATERIAL

A. Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from approved off base supply sources.

3.4 OPENING AND DRAINAGE OF EXCAVATION

A. Except as otherwise permitted, excavation areas providing adequate drainage. Transport overburden and other spoil material shall be removed from the site to off base locations.

3.5 SHORING

A. General Requirements

1. Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

B. Geotechnical Engineer

1. Hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.6 GRADING AREAS

A. Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory and wasted materials as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.7 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

A. Do not excavate to final grade until just before concrete is to be placed. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.8 GROUND SURFACE PREPARATION

A. General Requirements

1. Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inch and compact the upper 12 inches of exposed subgrade as specified for the adjacent fill.

B. Frozen Material

1. Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheep foot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.9 UTILIZATION OF EXCAVATED MATERIALS

A. Dispose all unsatisfactory or excess satisfactory materials removed from excavations off-site. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes.

3.10 BURIED TAPE AND DETECTION WIRE

A. Buried Warning and Identification Tape

1. Provide buried utility lines with utility identification tape. Bury tape 12 inch below finished grade; under pavements and slabs, bury tape 6 inch below top of subgrade.

B. Buried Detection Wire

1. Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inch above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over its entire length. Install wires at manholes between the top of the corbel and the frame and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.11 BACKFILLING AND COMPACTION

A. Prepare ground surface on which backfill is to be placed as specified in paragraph GROUND SURFACE PREPARATION. Provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

B. Trench Backfill

1. Backfill trenches to the grade shown. Only backfill the water and sewer trench to 1 foot above the top of pipe prior to performing the required pressure tests. Leave the joints and

couplings uncovered during the pressure test. Replacement of Unyielding Material Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material. For Leachate backfill requirements, see 33 05 05.31-2, Section 3.2.D.1.

2. Replacement of Unstable Material

   a. Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inch loose thickness.

3. Bedding and Initial Backfill

   a. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to top of pipe to 95 percent of ASTM D 1557 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

      1) Clean, coarsely graded natural gravel, crushed stone or a combination thereof or having a classification of GW, GP in accordance with ASTM D 2487 for bedding and backfill.

4. Final Backfill

   a. Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

      1) Roadways, Railroads, and Airfields: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

C. Backfill for Appurtenances

1. After the manhole, catch basin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.12 SPECIAL REQUIREMENTS

A. Special requirements for both excavation and backfill relating to the specific utilities are as follows:

B. Water Lines

1. Excavate trenches to a depth that provides a minimum cover of 5 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

C. Leachate Lines

1. See 33 05 33.23 and 33 05 73 for special requirements.

D. Heat Distribution System

1. Free initial backfills material of stones larger than 1/4 inch in any dimension.

E. Electrical Distribution System

1. Provide a minimum cover of 24 inch from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

F. Rip-Rap Construction

1. Construct rip-rap in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

2. Stone Placement

a. Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above.

3.13 SUBGRADE PREPARATION

A. Construction

1. Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 6 inch below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. After rolling, do not show deviations for the surface of the subgrade for roadways greater than 1/2 inch when tested with a 12-foot straightedge applied both parallel and at right angles to the centerline of the area. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

B. Compaction

1. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least 95 percent of laboratory maximum density.

2. Subgrade for Pavements

a. Compact subgrade for pavements to at least 92 percentage laboratory maximum density for the depth below the surface of the pavement shown.

3. Subgrade for Shoulders

a. Compact subgrade for shoulders to at least 92 percentage laboratory maximum density for the full depth of the shoulder.

3.14 FINISHING

A. Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, top soiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

B. Subgrade and Embankments

1. During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

C. Capillary Water Barrier

1. Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

D. Grading Around Structures

1. Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.15 TESTING

A. Perform testing by a DOE validated testing facility. Determine field in-place density in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 6938. When ASTM D 6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D 1556. ASTM D 6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D 6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

B. In-Place Densities

1. One test per 3,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

2. One test per 3,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

C. Check Tests on In-Place Densities

1. If ASTM D 6938 is used, check in-place densities by ASTM D 1556 as follows:

   a. One check test per lift for each 3000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

   b. One check test per lift for each 3000 square feet, of fill or backfill areas compacted by hand-operated machines.

D. Moisture Contents

1. In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions.

During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

E. Optimum Moisture and Laboratory Maximum Density

1. Perform tests for each type material or source of material to determine the optimum moisture and laboratory maximum density values. One representative test per 500 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

F. Tolerance Tests for Subgrades

1. Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

G. Displacement of Sewers

1. After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Contracting Officer. Inspect pipe sizes larger than 36 inch, while inspecting smaller diameter pipe by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.16 DISPOSITION OF SURPLUS MATERIAL

A. Provide surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber as removed from Government property as directed by the Contracting Officer.

END OF SECTION 31 00 00

SECTION 31 10 00

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1. SD-03 Product Data Non-saleable Materials

   a. Written permission to dispose of such products on private property shall be filed with the Contracting Officer.

2. SD-04 Samples Tree wound paint

   a. Samples in cans with manufacturer's label.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 PROTECTION

A. Utility Lines

1. Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer in ample time to minimize interruption of the service.

3.2 CLEARING

A. Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint.

3.3 GRUBBING

A. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

3.4 DISPOSAL OF MATERIALS

A. Non-saleable Materials

1. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, except for salable timber, shall be disposed of outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such product and will also state the areas in which they may be placed.

END OF SECTION 31 10 00

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade and pavements.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete pavements.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.
8. Excavating well hole to accommodate elevator-cylinder assembly.

B. Related Requirements:

1. Section 01 32 00 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
2. Section 31 10 00 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 31 50 00 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
4. Section 32 15 40 "Crushed Stone Surfacing" for gravel top and base courses.

1.2 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 01 22 00 "Unit Prices."

B. Quantity allowances for earth moving are included in Section 01 21 00 "Allowances."

C. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.

1. 24 inches outside of concrete forms other than at footings.
2. 12 inches outside of concrete forms at footings.
3. 6 inches outside of minimum required dimensions of concrete cast against grade.
4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
5. 6 inches beneath bottom of concrete slabs-on-grade.
6. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, or ripping, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct preexcavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Controlled low-strength material, including design mixture.
2. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Warning Tape: 12 inches long; of each color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D1557.

C. Seismic survey report from seismic survey agency.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 01 50 00 "Temporary Facilities and Controls" and Section 31 10 00 "Site Clearing" are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 01 56 39 "Temporary Tree and Plant Protection" are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand per WSDOT 9-0.3.9(3).

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, Type I Type II or Type III.
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, 3/4-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: 36 to 42 lb/cu. ft. at point of placement, when tested according to ASTM C138/C138M.
2. Compressive Strength: 140 psi, when tested according to ASTM C495/C495M.

C. Produce conventional-weight, controlled low-strength material with 80-psi compressive strength when tested according to ASTM C495/C495M.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.
c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches outside of concrete forms other than at footings.
b. 12 inches outside of concrete forms at footings.

c. 6 inches outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches beneath bottom of concrete slabs-on-grade.
f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

A. Notify Owner when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under walks and pavements, use satisfactory soil material.
2. Under building slabs, use engineered fill.
3. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
3. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.18 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.19 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.20 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:

1. Section 01 32 33 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 31 20 00 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing.
8. Review abandonment or removal of excavation support and protection system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Land surveyor.

2. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Construction Manager's written permission.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:

1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
3. Compliance with requirements of authorities having jurisdiction.
4. Compliance with utility company requirements.
5. Compliance with railroad requirements.

2.2 MATERIALS

A. Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock.

D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

E. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

F. Tiebacks: Steel bars, ASTM A722/A722M.

G. Tiebacks: Steel strand, ASTM A416/A416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

3.2 INSTALLATION - GENERAL

A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.

1. Limit vertical offset of adjacent sheet piling to 60 inches.
2. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 BRACING

A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 MAINTENANCE

A. Monitor and maintain excavation support and protection system.

B. Prevent surface water from entering excavations by grading, dikes, or other means.

C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.

1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.

1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
2. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction, and abandon remainder.
3. Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00 "Earth Moving."
4. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION 31 50 00

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Concrete Paving. Including the Following:

1. Driveways.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for general building applications of concrete.
2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:

   a. Concrete mixture design.
   b. Quality control of concrete materials and concrete paving construction practices.

2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete paving Subcontractor.
   e. Manufacturer's representative of stamped concrete paving system used for stamped detectable warnings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:

1. Exposed Aggregate: 10-lb Sample of each mix.

D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of stamped detectable warnings ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.

B. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

D. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

E. Zinc Repair Material: ASTM A780/A780M.

2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C150/C150M, gray portland cement Type I/II.
2. Fly Ash: ASTM C618, Class C or Class F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.

B. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 3/4 to 1 inch nominal.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

2.6 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dayton Superior.

b. Sika Corporation.

F. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.7 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Slag Cement: 50 percent.
3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 3 percent plus or minus 1-1/2 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 4500 psi.
2. Maximum W/C Ratio at Point of Placement: 0.50.

3. Slump Limit: 8 inches, plus or minus 1 inch.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:

1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch.

1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.

4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:

1. Uniformly spread 40 lb/100 sq. ft. of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial brooming, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft..

1. Embed rock salt into plastic concrete with roller.
2. Cover paving surface with 1-mil-thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall

within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 13 13

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-applied joint sealants.
2. Hot-applied, fuel-resistant joint sealants.
3. Joint-sealant backer materials.
4. Primers.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each type of joint sealant and accessory.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.

2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS

A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D 7116, Type I or Type II.

B. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D 7116, Type III.

2.3 JOINT-SEALANT BACKER MATERIALS

A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.4 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.
2. Do not stretch, twist, puncture, or tear joint-sealant backings.
3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.5 PAVING-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within concrete paving.

1. Joint Location:

   Expansion and isolation joints in concrete paving.

   Contraction joints in concrete paving.

   Other joints as indicated.

2. Joint Sealant: Single-component, self-leveling, silicone joint sealant.

3. Joint-Sealant Color: Manufacturer's standard.

END OF SECTION 32 13 73

SECTION 32 15 40

CRUSHED STONE SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of the Subcontract apply to this Section.
2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:

1. Crushed stone paving course, compacted.

C. Related Sections:

1. Division 01 Section "General Requirements."
2. Division 01 Section "Special Procedures."
3. Division 31 Section "Rough Grading: for preparation of site for paving."
4. Division 31 Section "Backfilling" for compacted fill for paving.

1.2 REFERENCES

A. General:

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
3. Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.

B. American Association of State Highway and Transportation Officials:

1. AASHTO T 27 Sieve Analysis of Fine and Coarse Aggregates.

C. Washington State Department of Transportation:

1. WSDOT 9-03.9(3) Crushed Surfacing.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coarse Stone: Crushed, washed natural stone; free of shale, clay, friable materials and debris; graded in accordance with WSDOT 9.03.9(3) within the following limits:

Sieve Size	Base Course	Top Course
	Percent Passing	
1 1/4 inches	99 to 100	
1 inch	88 to 100	
3/4-inch		99 to 100
5/8-inch	50 to 80	
3/8-inch		80 to 100
No. 4	25 to 45	46 to 66
No. 40	3 to 18	8 to 24
No. 200	7.5 MAX	10.0 MAX
% FRACTURE	75 MIN	75 MIN
SAND EQUIVALENT	40 MIN	40 MIN

B. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.

PART 3 - EXECUTION

3.1 INSPECTION

A. A. The Owner may retain the services of an independent inspection agency to verify that compacted granular base and stabilized soil is dry and ready to receive work of this section.

B. The University may retain the services of an independent surveyor to verify that gradients and elevations of base are correct.

C. Beginning of installation means acceptance of existing conditions.

3.2 PLACING STONE PAVING

A. Spread stone material over prepared base to a total compacted thickness of inches.

B. Place stone in 3 inches layers and compact.

C. Level surfaces to elevations and gradients indicated.

D. Add small quantities of sand to stone mix as appropriate to assist compaction.

E. Compact placed stone materials to achieve 95% dry density.

F. Add water to assist compaction. With an excess water condition, rework topping and aerate to reduce moisture content.

G. Perform hand tamping in areas inaccessible to compaction equipment.

END OF SECTION 32 15 40

SECTION 32 31 13

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain-link fences.
2. Swing gates.

B. Related Requirements:

1. Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" for cast-in-place concrete equipment bases/pads for gate operators and controls and post footings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Inspect and discuss electrical roughing-in, equipment bases, and other preparatory work specified elsewhere.
2. Review coordination of interlocked equipment specified in this Section and elsewhere.
3. Review required testing, inspecting, and certifying procedures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
   a. Fence and gate posts, rails, and fittings.
   b. Chain-link fabric, reinforcements, and attachments.
   c. Accessories: Barbed wire.
   d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include accessories, hardware, and operational clearances.

C. Samples for Initial Selection: For each type of factory-applied finish.

D. Samples for Verification: For each type of component with factory-applied finish, prepared on Samples of size indicated below:

1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer, testing agency, factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence and gate.

C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Mockups: Build mockups to set quality standards for fabrication and installation.

1. Build mockup for typical chain-link fence and gate, including accessories.

a. Size: 10-foot length of fence.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.

b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

c. Faulty operation of gate operators and controls.

2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.

1. Design Wind Load: 42 psf (Ultimate)/ 25 psf (Allowable).

a. Minimum Post Size: Determine according to ASTM F 1043 for post spacing not to exceed 10 feet for Material Group IA, ASTM F 1043, Schedule 40 steel pipe.

b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

B. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire for Fabric: Wire diameter of 0.192 inch.
   a. Mesh Size: 2 inches.
   b. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft.
   c. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.
   d. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 2, 1.0 oz./sq. ft.
   e. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.
3. Aluminum Wire Fabric: ASTM F 1183, with mill finish, and wire diameter of 0.192 inch.
   a. Mesh Size: 2 inches.
4. Selvage: Twisted top and knuckled bottom.

2.3 FENCE FRAMEWORK

A. Posts and Rails H-2-837964, Sh. 4: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:

1. Fence Height: 84 inches.
2. Light-Industrial-Strength Material: Group IC-L, round steel pipe, electric-resistance-welded pipe.
   a. Line Post: 2.375 inches in diameter.
   b. End, Corner, and Pull Posts: 2.875 inches.
3. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.
   a. Line Post: 2.375 inches in diameter.
   b. End, Corner, and Pull Posts: 4.0 inches in diameter.
4. Horizontal Framework Members: Intermediate, top, and bottom rails according to ASTM F 1043.
   a. Top Rail: 1.66 inches in diameter.
5. Brace Rails: ASTM F 1043.
6. Metallic Coating for Steel Framework:
   a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.
   b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.

c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil-thick, zinc-pigmented coating.

d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.

e. Coatings: Any coating above.

2.4 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type I: Aluminum coated (aluminized).

2. Type II: Zinc coated (galvanized) by electrolytic process, with the following minimum coating weight:

a. Class 3: Not less than 0.8 oz./sq. ft. of uncoated wire surface.

b. Class 4: Not less than 1.2 oz./sq. ft. of uncoated wire surface.

c. Class 5: Not less than 2 oz./sq. ft. of uncoated wire surface.

d. Matching chain-link fabric coating weight.

3. Type III: Zn-5-Al-MM alloy with the following minimum coating weight:

a. Class 60: Not less than 0.6 oz./sq. ft. of uncoated wire surface.

b. Class 100: Not less than 1 oz./sq. ft. of uncoated wire surface.

c. Matching chain-link fabric coating weight.

B. Aluminum Wire: 0.192-inch-diameter tension wire, mill finished, according to ASTM B 211, Alloy 6061-T94 with 50,000-psi minimum tensile strength.

2.5 SWING GATES

A. General: ASTM F 900 for gate posts and double swing gate types.

1. Gate Leaf Width: 26 feet.

2. Framework Member Sizes and Strength: Based on gate fabric height of 84 inches or less.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framework.

2. Aluminum: ASTM B 429/B 429M; mill finish.

3. Gate Posts: Round tubular steel

4. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

E. Hardware:

1. Hinges: 360-degree inward and outward swing.

2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

3. Lock: Manufacturer's standard internal device.
4. Closer: Manufacturer's standard.

2.6 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts, integral with post cap, for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.
2. Provide corner arms at fence corner posts unless extended posts are indicated.
3. Single-Arm Type: Type II, vertical arm.

I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

   a. Hot-Dip Galvanized Steel: 0.148-inch-diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

   a. Polymer coating over metallic coating.

2.7 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.8 GROUNDING MATERIALS

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of project boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Owner Representative.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing on established boundary lines inside property line.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
   a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.
   b. Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.
   c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.
   d. Posts Set into Holes in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth of 36 inches. Protect post top to prevent distortion.

D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

E. Line Posts: Space line posts uniformly at 10 feet o.c.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 84 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
2. Extended along top of extended posts and top of fence fabric to support barbed tape.

H. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

I. Intermediate and Bottom Rails: Secure to posts with fittings.

J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

K. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

L. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.

M. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GROUNDING AND BONDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.

2. Install ground rods and connections at maximum intervals of 1500 feet.

3. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

4. Ground fence on each side of gates and other fence openings.

a. Bond metal gates to gate posts.

b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.

2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.

2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

4. Make above-grade ground connections with mechanical fasteners.

5. Make below-grade ground connections with exothermic welds.

6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

H. Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Grounding Tests: Comply with requirements in Section 26 41 13 "Lightning Protection for Structures."

C. Prepare test reports.

3.7 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13

SECTION 33 05 05.31

HYDROSTATIC TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hydrostatic and leakage testing of leachate piping and associated components.

B. Related Requirements:

1. 33 06 05, “Piping Schedules” for piping schedule.
2. 33 05 31.13, “Polyvinyl Chloride Pressure Pipe” for PVC leachate piping.
3. 33 05 33.23, “Polyethylene Pressure Pipe and Tubing (AWWA C901 and AWWA C906)” for HDPE leachate piping.

C. References

1. ASTM F1417, *Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air*
2. ASTM F2164, *Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure*
3. ECR-18-001801, *IDF Leachate Tank 219A201 and 219E201 Connection*

1.3 ACTION SUBMITTALS

A. Testing Plan: Submit prior to testing and include at least the information that follows:

1. Testing dates
2. Piping systems and section(s) to be tested
3. Test type
4. Method of isolation
5. Sample of test report form
6. Certifications of Calibration for testing equipment

1.4 INFORMATIONAL SUBMITTALS

A. Certified Test Report

1. Provide manufacturer’s calibration recommendations and current calibrations of pressure gauge(s).
2. Signed and approved by testing personnel

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notify Construction Manager in writing 5 days in advance of testing. Perform testing in presence of Construction Manager.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment
2. Make taps for test gauges in piping prior to testing.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. Items that do not require testing include:
   a. Piping inside wetwells (i.e., leachate tank transfer sump) and wetwell isolation valves, tank overflows to atmospheric vented drains, tank atmospheric vents, and slotted piping.
5. Test sections may be filled with water and allowed to stand under low pressure prior to testing.

C. Other Piping:

1. Perform testing of other pipe service types using the same methods outlined for pressure piping.

3.2 HYDROSTATIC TEST

A. General: Hydrostatic testing shall be performed on all newly installed single-wall pipe, inner carrier pipes, and PVC piping.

B. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

C. Test Pressure:

1. Per Section 33 06 05, “Piping Schedules”

D. HDPE Carrier Piping:

1. Perform testing on installed piping prior to backfilling of trenches in accordance with ASTM F2164.
2. The pipeline test section shall be restrained against movement in the event of catastrophic failure.
3. Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.
4. Maximum filling velocity of 0.25 feet per second applied over full area of pipe.
5. Vent piping during filling by opening vents at high points of piping system or loosening flanges, using at least four bolts, or use equipment vents to purge air pockets.
6. Test Procedure: The test procedure consists of an initial expansion phase and then the test phase. Prior to the test procedure, the test medium and pipe test section shall be allowed time to equalize in temperature. Testing shall not be allowed if temperatures of the test medium or pipe test section exceed 80 °F.
7. Examine test section to ensure that connection are tight, necessary restraints are in place and secure, and components that should be isolated or disconnected are isolate or disconnected.
8. Maintain the test pressure for a period of 4 hours during the initial expansion phase by adding water as needed.

9. At the beginning of the test phase after the initial expansion phase, reduce pressure by 10 psi. Maintain this test pressure for a period of 1 hour.
10. Under no circumstances shall the testing be allowed to exceed 8 hours.
11. Acceptance Criteria: The test phase is passed, and the pressure test is acceptable, if the pressure remains steady (within 5 percent of the test phase beginning pressure) without the addition of makeup water for 1 hour and there are no indications of leakage, visible or otherwise.
    a. If acceptance criteria are not met, any leakage points shall be fixed, and any other changes shall be made to the piping system as necessary. Allow 8 hours to elapse between test and retest. Retest and repeat until acceptance criteria are met.
12. Empty Pipe of water prior to final cleaning.

E. PVC and Non-HDPE Piping:

1. Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.
2. Maximum filling velocity of 0.25 feet per second applied over full area of pipe.
3. Vent piping during filling by opening vents at high points of piping system or loosening flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage. No fluid shall be added to the system, and system shall not drop below 95 percent of the test pressure during the test period.
5. Examine exposed joints and connections for leakage.
6. Acceptance Criteria: The test phase is passed, and the pressure test is acceptable, if there are no indications of leakage, visible or otherwise.
    a. If acceptance criteria are not met, any leakage points shall be fixed, and any other changes shall be made to the piping system as necessary. Retest and repeat until acceptance criteria are met.
7. Empty pipe of water prior to final cleaning.

3.3 PNEUMATIC TEST

A. General: Pneumatic testing shall be performed for outer pipe of double-wall HDPE piping and atmospheric drains in accordance with ASTM F1417.

B. Double-Wall Pipe: Inner carrier pipe shall be full of water when outer containment pipe is tested to prevent damage to carrier pipe and riser pipes.

C. Equipment:

1. Gauges shall be calibrated within manufacturer’s recommended frequency and calibration shall be current.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 10 psi or less.
4. Restrain pipeline test section against movement in the event of catastrophic failure.
5. Restrain plugs used to close lines to prevent blowoff.

D. Procedure:

1. Examine test section to ensure that connection are tight, necessary restraints are in place and secure, and components that should be isolated or disconnected are isolate or disconnected.
2. Slowly introduce air into pipe section until internal air pressure reaches required test pressure (a maximum 5% gauge loss is acceptable).
3. Allow 2 minutes minimum for air temperature to stabilize.
4. Examine exposed joints and connections for leakage using mild soap solution (strong detergents shall be avoided) or other non-deleterious leak detecting fluid applied to the joints. Liquid bubbles determine source of leakage. Depressurize immediately if butt fusion leakage is discovered.
5. Maintain test pressure for 10 to 60 minutes, but not more than 60 minutes.
6. Acceptance Criteria: The test phase is passed, and the pressure test is acceptable, if there is no loss in pressure and no indications of leakage, visible or otherwise.
    a. If acceptance criteria are not met, depressurize the section, and repair any leakage points and make any other changes made to the piping system as necessary. Allow the test section to remain depressurized for 8 hours before retesting. Retest and repeat until acceptance criteria are met.
7. Clean soap solutions or leak detecting fluids off the system with clean water.

END OF SECTION 33 05 05.31

SECTION 33 05 31.13

POLYVINYL CHLORIDE PRESSURE PIPE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes PVC leachate piping and associated components inside the transfer buildings.

B. Related Requirements:

1. 33 06 05, "Piping Schedules" for piping schedule.
2. 33 05 33.23, "Polyethylene Pressure Pipe and Tubing (AWWA C901 and AWWA C906)" for HDPE leachate piping.

C. References

1. ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250*
2. ASTM A193, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*
3. ASTM A194, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*
4. ASTM D1784, *Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds*
5. ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120*
6. ASTM D2464, *Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*
7. ASTM D2466, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40*
8. ASTM D2467, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80*
9. ASTM D2564, *Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems*
10. ECR-18-001801, *IDF Leachate Tank 219A201 and 219E201 Connection*

1.3 ACTION SUBMITTALS

A. Product data sheets, complete catalog information, descriptive literature, specifications, and identification of materials of construction.

B. Testing equipment: certified calibrations, manufacturer's product data, and test procedures.

C. Qualifications

1. Solvent Welders: list of solvent welders and current test records for solvent welder(s) for field solvent welding.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate of Compliance

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Schedule 80, PVC: Type I, Grade I, or Class 12454-B conforming to ASTM D1784 and ASTM D1785; pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.

B. Threaded Nipples: Schedule 80 PVC.

C. Fittings: Schedule to match pipe: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.

2.2 JOINTS

A. Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.

B. Flanges: one piece, molded hub type PVC flat face flange in accordance with fittings above, 125-pound ANSI B16.1 drilling

1. Bolting: ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.

2. Gaskets:

a. Flat Face Mating Flange; flat ring 1/8 inch ethylene propylene (EPR) rubber.

b. Raised Face Mating Flange: Flat ring 1/8 inch ethylene propylene (EPR) rubber with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

C. Solvent Cement: As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.

D. Thread Lubricant: Teflon tape.

2.3 VALVES

A. General

1. Valve shall be same size as adjoining pipe.

2. Valve ends to suit adjacent piping.

3. Size operator to operate for the full range of pressures and velocities.

4. Valve to open by turning counterclockwise.

5. Factory mount operator, actuator, and accessories.

6. Provide nametag for each valve. Nametag shall include valve tag number and be constructed of 16-gauge Type 304 stainless steel, letters shall be 3/16-inch imposed, affix to valve with 16 or 18-gauge stainless steel wire.

B. Ball Valve

1. Use Type V331 PVC Ball Valve 3 and 4 inches:

2. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, viton o-ring stem, face and carrier seals, and entry design with dual union,

solvent-weld socket ends, or single union ball valve with flanged ends drilled to ANSI B16.1.

3. Recommended manufacturer: TRUE UNION

C. Vacuum Breaker

1. 1-inch NPT inlet and outlet, PVC body, EPDM diaphragm, working pressure 100 psi.

2. Recommended manufacturer: PLAST-O-MATIC; Series VBM.

D. Air Release Valve

1. Install upright at highest point in piping system.

2. 1 1/2-inch NPT inlet and outlet, PVC body, EPDM seals, rated for minimum flow of 200 gpm, pressure rating at 75°F of 150 psi.

3. Closes at 0 psi in presence of liquid; bubble tight seal at 10 psi or lower system pressure.

4. Recommended manufacturer: PLAST-O-MATIC; Series ARV.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

3.2 PREPARATION

A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

B. Damaged coatings and linings: repair using original coating and lining materials in accordance with manufacturer's instructions.

3.3 INSTALLATION

A. Join pipe and fittings in accordance with manufacturer's instructions.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.

2. Bolt Holes: "two-hole orientation;" straddle vertical centerlines, align with connecting equipment flanges, or as shown on drawings.

3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

4. Install annular ring filter gasket at joints of raised-face flange.

3.4 CLEANING

A. Clean all piping to remove all foreign materials including dirt, grease, and other matter.

B. Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

C. If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

F. Acceptance leakage testing shall be completed.

END OF SECTION 33 05 31.13

SECTION 33 05 33.23

POLYETHYLENE PRESSURE PIPE AND TUBING (AWWA C901 AND AWWA C906)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes all carrier and double containment high-density polyethylene (HDPE) leachate piping and associated components.

B. Related Requirements:

1. 31 00 00, "Earthwork" for pipe bedding, trenching, and backfill.
2. 33 05 05.31, “Hydrostatic Testing” for hydrostatic and pneumatic testing of leachate transfer piping.
3. 33 06 05, “Piping Schedules” for piping schedule.

C. References

1. ASTM D698, *Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))*
2. ASTM D2657, *Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings*
3. ASTM D3350, *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*
4. ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*
5. ASTM F714, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter*
6. AWWA C901, *Polyethylene (PE) Pressure Pipe and Tubing, ½ in. (13 mm) Through 3 in. (76 mm), for Water Service*
7. AWWA C906, *Polyethylene (PE) Pressure Pipe and Fittings, 4 in. thru 65 in. (100 mm Through 1650 mm), for Waterworks*
8. ECR-18-001801, *IDF Leachate Tank 219A201 and 219E201 Connection*
9. *Handbook of Polyethylene Pipe*, 2nd ed., Plastic Pipe Institute.

1.3 ACTION SUBMITTALS

A. Manufacturer’s design guidance that includes spacer maximum spacing, attachment method, orientation, and material type.

B. Manufacturer’s certificates of compliance for all pipe and fittings. Certificates shall acknowledge that pipe and fittings meet the requirements of this specification.

C. The manufacturer shall submit a Certificate of Compliance of the HDPE pipe supplied, which will include the pipe grade (PE3608) and cell classification per ASTM D3350.

D. Descriptive literature about the fusion equipment to be used and certification from the pipe supplier or manufacturer that the joining technician(s) is certified and experienced in heat fusion joining of HDPE pipe. Certification shall contain the following information:

1. Name of technician(s)
2. Date of certification(s)
3. Statement by the pipe supplier that the technician(s) is certified in the means and methods of joining the supplier's pipe and fittings using butt fusion techniques
4. Make(s) and model(s) of fusion equipment the technician(s) is certified to join pipe with

1.4 INFORMATIONAL SUBMITTALS

A. Catalog and manufacturer's data sheets for HDPE pipe and fittings.

B. Catalog and manufacturer's data sheets, electrofusion couplers, mechanical cutters, and appurtenances.

PART 2 - PRODUCTS

2.1 MATERIALS

A. HDPE pipe resin shall contain no more than 2 percent clean recycled polymer by weight.

B. HDPE pipe resin shall meet or exceed the requirements of ASTM D3350 for PE3608 material with a cell classification of 345434C or better (better cell classifications use the same six number scheme, except that one or more of the numbers is greater than the corresponding number in this specification).

C. HDPE pipe SDR shall be as indicated on the Piping Schedule.

2.2 QUALITY

A. The pipe shall have uniform wall thickness, color, opacity, and density.

B. The pipe shall be free of visible cracks, holes, blisters, bubbles, undispersed raw materials, and contamination of foreign matter. Any pipe with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

2.3 FORM

A. Pipe may be continuous extruded seamless piece or in sections.

2.4 FITTINGS

A. HDPE fittings shall contain no more than 2 percent clean recycled polymer by weight.

B. HDPE fitting resin shall meet or exceed the requirements of ASTM D3350 for PE3608 material with a cell classification of 345434C or better.

C. The fittings shall have uniform wall thickness, color, opacity, and density.

D. The fittings shall be free of visible cracks, holes, blisters, bubbles, undispersed raw materials, and contamination of foreign matter. Any fitting with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

E. HDPE fittings shall be compatible with the double containment system.

F. HDPE fittings shall be from the same manufacturer as the pipe where possible.

G. HDPE fittings shall be molded or fabricated from HDPE pipe and shall have the same or numerically smaller SDR than its connecting pipe.

H. All reducing tees shall be factory molded if available as a standard item by any manufacturer with HDPE pipe meeting the requirements of this specification. If not available as a standard item, branch saddle reducing tees shall be used. Reducers shall be shop manufactured. Fabricated branch connections will not be allowed if branch saddle connections are listed in the manufacturer’s catalog.

I. All molded polyethylene fittings shall have the same, or higher, pressure rating as the adjoining pipe when installed in accordance with the manufacturer’s recommendations and specifications.

2.5 DOUBLE CONTAINMENT PIPE

A. HDPE containment pipe shall contain no more than 2 percent clean recycled polymer by weight.

B. HDPE containment pipe shall meet or exceed the requirements of ASTM D3350 for PE3608 material with a cell classification of 345434C or better.

C. The containment pipe shall have uniform wall thickness, color, opacity, and density.

D. The containment pipe shall be free of visible cracks, holes, blisters, bubbles, undispersed raw materials, and contamination of foreign matter. Any containment pipe with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

E. Double containment pipe shall consist of a carrier pipe installed within a containment pipe. All pipe and fittings shall provide an annular space between the carrier and containment pipes to permit flow of fluid from the carrier pipe.

F. Support spacers shall be nonmetallic, corrosion-resistant material with the same or better chemical compatibility properties as the HDPE pipe.

G. Spacer intervals and attachment method(s) to the carrier pipe shall be in accordance with the manufacturer’s recommendations. Spacing shall be reduced to maintain the annulus between the carrier and containment pipes, if required.

H. Spacers shall be positioned to allow for unrestricted passage of fluid from the carrier pipe.

I. Spacers shall be chamfered at both ends to allow for removal of carrier pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. All HDPE pipe and fittings shall be installed in conformance with applicable code requirements.

3.2 DIMENSIONS

A. Piping dimensions shown on the Drawings are approximate. It is the Construction General Contractor’s responsibility to furnish and install piping of the proper dimensions, which will properly fit with the connecting elements, pipes, fittings, pumps, etc.

3.3 INSTALLATION

A. Pipe shall be handled and stored in such a manner as to ensure a sound, undamaged condition.

B. Pipe shall be cut in a neat, workmanlike manner using a mechanical cutter that will not damage the pipe.

C. Joining of HDPE pipe to HDPE pipe shall be accomplished by thermal butt fusion. Electrofusion couplings shall only be allowed when access to piping is restricted. Pipe shall be joined per ASTM D2657 and manufacturer’s recommendations.

D. Single butt fusion welds shall be used to create pipe sections as long as practicable. Fabricated pipe sections and fittings may be joined by the double butt fusion process.

E. During installation, the pipe shall not be pulled across sharp projections that could cause gouges, kinks, or other types of damage.

F. Buried HDPE pipe shall be installed with excess length between anchor points so that contraction caused by a temperature drop to 40 °F will produce the length of pipe between two points as shown on the Drawings. Excess pipe depends on the temperature of the pipe at the time of installation. Measure installation temperature with a strip thermometer laid directly on the pipe. Adjust length of pipe according Table 1 to for buried piping and verify length and temperature of pipe immediately before burial (based on a coefficient of thermal expansion of 9.0×10^{-5} in/in•°F for PE3XXX pipe, as listed in the Plastics Pipe Institute Handbook of Polyethylene Pipe Chapter 3, Appendix E, Table E.1).

Table 1. Excess Pipe Lengths Based on Installation Temperature

Installation Temperature (°F)	Excess Pipe Length (in./100 ft.)
50	1.1
60	2.2
70	3.2
80	4.3
90	5.4
100	6.5
120	8.6

G. Excavate trench bottom and sides to permit visual inspection and testing of entire flange, valve, or connection.

H. Pipe bedding and embedment shall be in accordance with ASTM D2321, Class I or Class II soils with a maximum particle size of ½-in. and compacted to 90% standard proctor density per ASTM D698 as specified in 31 00 00, EARTHWORK. Pipe bedding shall be a minimum of 4 inches thick.

I. The pipe shall not be dropped into the trench. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe. The full length of the pipe shall be firmly bedded on the trench bottom.

J. The pipe shall be bedded in such a way as to maintain grade with a tolerance of 0.0 percent, + 0.5 percent with a uniform, constant grade and no localized low spots.

K. Keep trench dry until pipe laying and joining are completed.

L. Prevent foreign material from entering pipe during placement.

M. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.

N. After joint has been made, check pipe alignment and grade.

O. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

P. Prevent uplift and floating of pipe prior to backfilling.

Q. Place pipe along pipe runs starting at one end and moving towards the other to avoid joints that will not be feasible with butt fusion.

R. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.0 foot from position shown on drawings.

S. Minimum 3 feet 6 inches of pipe cover is required from finished elevation of overlying material, unless otherwise shown.

T. Trenching and backfilling operations shall be conducted in accordance with the requirements of ASTM D2321 and 31 00 00, EARTHWORK. If trenching is used, underlying materials shall not be disturbed or damaged in anyway. Backfilling operations shall ensure that no voids are present under or at the sides of the pipe. Backfill shall initially be placed on the top of the pipe, then hand compacted. The remainder of the trench shall then be backfilled and compacted by hand or with a power tamper only. The trench width shall be a minimum of 24 inches wide for 6 inch pipe and a minimum of 19 inches wide for 2 inch pipe.

U. Placement of gravel around pipes shall be by hand.

V. Locator ribbon shall be installed as specified in 31 00 00, EARTHWORK.

W. Underground pipelines shall be identified by use of a plastic ribbon or stencil no less than 3 inches in width with a message printed on the ribbon which identifies the actual pipeline contents. Marking tapes or stencils shall be placed on existing lines where they are exposed by trenching operations. The ribbon shall be wrapped around the pipeline at no less than 1 wrap per 3 feet of run.

X. Where flanged joints are used, the bolts shall be evenly torqued using a crossing pattern. Torque values shall be as recommended by the flange manufacturer. Flanged joints shall be retorqued after one hour or more has passed. Apply anti-seize compound on all threaded surfaces before tightening.

Y. Flaws (minor imperfections, damaged areas, etc.) in HDPE pipe with a depth of 10 percent or less of the nominal wall thickness will not require repair or replacement. In double containment systems, carrier pipe with flaws deeper than 10 percent of the wall thickness shall be replaced. Single pipe or containment pipe with flaws between 10 and 25 percent of the wall thickness shall be repaired in accordance with the pipe manufacturer’s recommendations. The Construction General Contractor shall certify in writing that the repaired area will have material properties that meet or exceed those of intact pipe. Any pipe with flaws deeper than 25 percent of the nominal wall thickness shall be rejected.

Z. All valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

AA. HDPE pipe connected to heavy fittings and rigid structures (such as manholes) shall be supported in such a manner that no subsequent relative movement between HDPE pipe at flanged joint and rigid structures is possible.

BB. Butt-fusion shall be performed in accordance with pipe manufacturer’s recommendations as to equipment and technique.

CC. Remove all plastic debris from inside pipe.

3.4 CLEANING

A. Clean all piping to remove all foreign materials including dirt, grease, and other matter.

B. Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

C. If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

F. Acceptance leakage testing shall be completed as described in 33 05 05.31, HYDROSTATIC TESTING.

END OF SECTION 33 05 33.23

SECTION 33 05 73

POLYETHYLENE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes leachate tank transfer sump on leachate tank connection line.

B. Related Requirements:

1. 33 05 33.23, "Polyethylene Pressure Pipe and Tubing (AWWA C901 and AWWA C906)" for leachate transfer piping interfacing with sump.
2. 31 00 00, "Earthwork"

C. References:

1. ANSI B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard*
2. ASTM D1784, *Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds*
3. ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*
4. ASTM D3350, *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*
5. ASTM F1759, *Design of High-Density Polyethylene (HDPE) Manholes for Subsurface Applications*
6. ASTM F714, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter*
7. ECR-18-001801, *IDF Leachate Tank 219A201 and 219E201 Connection*

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Field Verified fabrication drawings.

C. Lifting Eye Load Test Report.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The manhole shall be fabricated from high density polyethylene (HDPE). The riser and base shall be made of HDPE plastic compound having a cell classification of 345334C per ASTM D3350. Alternate cell classifications are acceptable if one or more of the six numbers in the cell classification are greater than the minimum. Pipe shall be rated PE3608.

B. HDPE pipe used to fabricate the HDPE manhole shall meet all product requirements of 33 05 33.23, POLYETHELENE PRESSURE PIPE AND TUBING (AWWA C901 AND AWWA C906). Pipe shall be 54 inch OD with SDR 21.

C. Flatstock shall be minimum of 1.5 inches thick up to 3 inches thick inclusive. Flatstock shall be compatible with pipe and shall have a cell classification of 345334C per ASTM D3350 or better (recommended supplier: Professional Plastics, HDPE Pipe Grade Sheet). Flatstock shall be cut to 56 inch diameter for base.

D. Welding rods, connecting couplings, pipe collars and other materials, as required to complete the installation, shall be of the same plastic as the flatstock.

E. Access hatch shall be large enough to provide uninhibited access to the sump and valves. Door leaves shall be reinforced for a 300 pound per square foot live load. The frame shall drain water out through a 1 1/2-inch pipe coupling. The floor access hatch shall be equipped with a flush steel lifting handle that does not protrude above the cover, and 316 stainless steel hold open arms that automatically keep the covers in their upright, open positions. A staple for a padlock shall be supplied for security. The access hatch shall be furnished with one coat of shop primer. Installation shall be in accordance with the manufacturer’s attached instructions. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of five years.

1. Recommended Manufacturer: U.S.F. Fabrication, Model TPD 68 inch × 68-inch overall size with clear opening of 60 inch × 57 inch.
2. Notch top of HDPE manhole pipe to accommodate access hatch structure.

F. 2-inch PVC Ball Valves

1. PVC Type 1, Grade 1 (ASTM D1784, Cell Classification 12454) or CPVC (ASTM D1784, Cell Classification 23447). All sizes shall be of true union design.
2. All O-rings shall be EPDM or FPM. Seats shall be PTFE. Seats shall be reversible to allow field rebuild.
3. ANSI B16.5 Class 150 drilled flanges.
4. Shall be pressure-rated for 150 PSI at 70 degrees F non-shock.
5. Recommended Manufacturer: Hayward Flow Control, TBH 1 200A OF E 0 0 00

G. Ball Valve Stem Extension Kits

1. PVC construction, 1-inch schedule 80 pipe extension, solvent weld to matching 2-inch PVC Ball valves.
2. Recommended Manufacturer: Hayward Flow Control, Kit Part Number TBEXTK200

H. Stub outs

1. Stub outs to be fabricated from 2-inch PE3608 pipe meeting the product requirements of 33 05 33.23, POLYETHELENE PRESSURE PIPE AND TUBING (AWWA C901 AND AWWA C906).
2. Field verify locations of stub outs prior to fabrication.
3. Install fusion welded gussets to inside and outside pipe (top and bottom) using flatstock.
4. Install a butt fused flange adapter to match with the ball valve on the inside of the manhole.

I. Lifting Eyes

1. Provide three lifting eyes for loading, unloading, and installation.

PART 3 - EXECUTION

3.1 FABRICATION

A. Confirm elevations using in-field measurements.

B. Inlet and outlet piping shall be installed as shown on Drawings by fabricator prior to delivery to site.

C. The manhole shall be fabricated with the minimum number of welds practical.

D. All welds shall be heat fused in accordance with manufacturer's recommendations on equipment specifically designed for welding thermoplastic sheets or extrusion welded by pre-certified welders.

E. Where flanged joints are used, the bolts shall be evenly torqued using a crossing pattern. Torque values shall be as recommended by the flange manufacturer. Flanged joints shall be retorqued after one hour or more has passed. Apply anti-seize compound on all threaded surfaces before tightening.

F. Load test lifting eyes to validate design. Submit load test report.

3.2 INSTALLATION

A. Manhole shall be handled and stored according to manufacturer's recommendations and in such a manner as to ensure a sound undamaged condition.

B. Place manhole on level base (minimum 12 inches depth) consisting of ASTM D2321, Class I soil compacted to minimum 95% standard proctor density as identified on Drawings.

C. Weld HDPE leachate transfer containment pipe to manhole stub outs in accordance with all product requirements of 33 05 33.23, POLYETHELENE PRESSURE PIPE AND TUBING (AWWA C901 AND AWWA C906).

D. Install ball valve stem extension kits using schedule 80 solvent-welded PVC to enable workers to access ball valves from surface grade through access hatch. Confirm operability of ball valves using extension kits. Close ball valves.

E. Perform leakage test.

F. Backfill in accordance with 31 00 00, EARTHWORK; install concrete footing forms, access hatch, drain, and drain rock.

G. Install access hatch in accordance with Drawings and manufacturer instructions.

H. Pour concrete footing.

3.3 LEAKAGE TEST

A. After all HDPE manhole pipe stub out connections have been completed, and prior to backfilling, perform leakage test as follows.

   1. Provide necessary shoring during leakage testing per manufacturer's recommendations to compensate for lack of backfill.

   2. Completely fill manhole with water for 8 hours.

   3. Visually inspect manhole at regular 1-hour intervals to confirm that no leakage has occurred.

   4. Repair any defects and retest in event of failure.

END OF SECTION 33 05 73

SECTION 33 06 05

SCHEDULES FOR UTILITY PIPING

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

Item	Size	Description
General	-	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
Pipe	-	Pipe SDR shall be AS INDICATED on the Piping Schedule Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin. Pipe wall thickness shall reflect the required SDR* and diameter, as shown in ASTM F714, Table 7 or ASTM D3035, Tables 3 and 4. *SDR: standard dimension ratio = OD/thickness
Fittings	≤ 6-inch ≥ 8-inch	Molded fittings, butt fusion joined, conforming to ASTM D3261 Molded if manufactured as a standard item or same as pipe, butt fusion joined, conforming to ASTM D3350
Electrofusion Couplers	-	Rigid, straight coupler constructed from injection-molded polyethylene with embedded heating coils as manufactured by Central Plastics; or equivalent.
Flanges	-	ASTM A351 Type 316/CF8M stainless steel, class 150, ANSI B16.5 standard, convoluted back-up ring with one-piece polyethylene molded flange adaptor ends, same rating pressure as pipe.
Bolting	-	Stainless steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts. Manufacturer’s recommended anti-seize compound on all threads. Washers shall be same material as bolts.
Gaskets	-	Flat ring, 1/8-inch Viton.

POLYVINYL CHLORIDE (PVC) PIPE

Item	Size	Description
Pipe	All	Schedule 80 PVC; Type I, Grade I, or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to match pipe: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with fittings above, class 125 ANSI B16.1 drilling.
Bolting	All	Stainless steel, ASTM A193/A193M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Manufacturer's recommended anti-seize compound on all threads. Washers shall be same material as bolts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch EPR with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564
Thread Lubricant	All	Teflon tape.

PIPING SCHEDULE

Service Code	Size(s) (in.)	Exposure	Piping Material	Joint Type	Specification Section	Test Type	Test Pressure (psi)	Remarks
LH, LT	All	EXP	PVC	SW, FL, TH	33 05 31.13	H	75	SCHD 80
LT	3”	BUR	HDPE	BF	33 05 33.23	H	75	SDR 11
LT	4”	BUR	HDPE	BF	33 05 33.23	H	75	SDR 11
LTCP	2”	BUR	HDPE	BF	33 05 33.23	P	8	SDR 11
LTCP	6”	BUR	HDPE	BF	33 05 33.23	P	8	SDR 17
LTCP	8”	BUR	HDPE	BF	33 05 33.23	P	8	SDR 17

SERVICE CODE

LH Leachate Handling
LHCP Leachate Handling Containment Pipe
LT Leachate Transfer
LTCP Leachate Transfer Containment Pipe
RW Raw Water
PW Potable Water

EXPOSURE

EXP Exposed
BUR Buried

MATERIAL

PVC Polyvinyl Chloride
HDPE High Density Polyethylene
GSP Galvanized Steel Pipe
DI Ductile Iron

PRESSURE TEST

H Hydrostatic
P Pneumatic

JOINT TYPE

BF Butt Fused
FL Flanged
SW Solvent Weld
TH Threaded

END OF SECTION 33 06 05

Hanford Facility RCRA Permit Modification Notification Forms

Part V, Operating Unit 25
PUREX Storage Tunnels

Index

Submitted by Co-Operator:

12/10/2019

Deborah Singleton Date

Reviewed by DOE Program Office:

12-10-19

Duane Carter Date

Hanford Facility RCRA Permit Modification Form	
Unit: ***Unit Name***	Permit Part ***Part X, Operating Unit Group X***

Description of Modification:

Update the revision history information for Chapter 11

CLOSURE UNIT 25

Chapter 1.0	Part A Form, dated December 17, 2018
Chapter 3.0	Waste Analysis Plan, dated December 17, 2018
Chapter 4.0	Process Information, dated December 17, 2018
Chapter 11.0	Closure and Financial Assurance, dated **February 28, 2019**
Addendum E	Security, dated September 30, 2010
Addendum F	Preparedness and Prevention, dated December 17, 2018
Addendum G	Personnel Training, dated June 30, 2012
Addendum I	Inspection Requirements, dated December 17, 2018
Addendum J	Contingency Plan, dated December 17, 2018

Change date to coincide with Ecology signature approval on the Class 1 modification herein.

WAC 173-303-830 Modification Class Please mark the Modification Class:	Class 1	Class '1	Class 2	Class 3
		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

A.1. Administrative and informational changes. ..

Modification ~~Concurrence:~~ Approved [X] Yes [ ] No	Reviewed by Ecology: Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.07.23 13:15:00 -07'00'
	S. N. Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
Unit Name	***Part X, Operating Unit Group X***

Description of Modification:

Replace the following engineering drawings in Chapter 11 with the updated engineering drawings. These updates were due to completion of the PUREX Storage Tunnel #2 grouting activities.

Figure 11.8	H-2-837313	"Tunnel Number 2 Site Plan"
Figure 11.13	H-2-837312	"PUREX Tunnel NO. 2 Interim Stabilization Drawing List, Notes and Legend, #H-2-837312-1"
Figure 11.14	H-2-837314	"PUREX Tunnel NO. 2 Interim Stabilization Enlarged Site Plan 1, #H-2-837314-1"
Figure 11.15	H-2-837314	"PUREX Tunnel NO. 2 Interim Stabilization Enlarged Site Plan 2, #H-2-837314-2"
Figure 11.16	H-2-837316	"PUREX Tunnel NO. 2 Interim Stabilization Grout Insertion Device, #H-2-837316-1"
Figure 11.17	H-2-837317	"PUREX Tunnel NO. 2 Interim Stabilization Grout Insertion EXT Boom, #H-2-837317"

WAC 173-303-830 Modification Class	Class 1	Class ¹1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

A.1. Administrative and informational changes...

Modification ~~Concurrence~~: [X] Yes [ ] No
Approved

Reviewed by Ecology:

Schleif, Stephanie (ECY)
Digitally signed by Schleif, Stephanie (ECY)
Date: 2020.07.23 13:15:34 -07'00'

S. N. Schleif Date

Revision Instructions:

Revise CUG 25 Unit Specific Conditions as shown herein.

Revise CUG 25 Chapter 11.0 as shown herein.

PUREX STORAGE TUNNELS
CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have a "**Last Modification Date**" which represents the last date the portion of the unit has been modified. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Last modification to PUREX **February 28, 2019**

Chapters	Last Modification Date	Modification Number
Unit-Specific Conditions	02/28/2019	PCN-PUREX-2019-01
1.0 Part A Form	12/17/2018	8C.2018.5F
2.0 Reserved		
3.0 Waste Analysis Plan	12/17/2018	8C.2018.5F
4.0 Process Information	12/17/2018	8C.2018.5F
5.0 Reserved		
6.0 Reserved		
7.0 Reserved		
8.0 Reserved		
9.0 Reserved		
10.0 Reserved		
11.0 Closure and Financial Assurance	~~0~~12/~~28~~31/2019	PCN-PUREX-2019-03~~1~~
Addenda	**Last Modification Date**	**Modification Number**
A. Reserved		
B. Reserved		
C. Reserved		
D. Reserved		
E. Security	09/30/2010	
F. Preparedness and Prevention	12/17/2018	8C.2018.5F
G. Personnel Training	09/30/2012	
H. Reserved		
I. Inspection Requirements	12/17/2018	8C.2018.5F
J. Contingency Plan	12/17/2018	8C.2018.5F

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PUREX STORAGE TUNNELS
PART V, CLOSURE UNIT 25 PERMIT CONDITIONS

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
12/31/2019	PCN-PUREX-2019-03
02/28/2019	PCN-PUREX-2019-01
12/17/2018	8C.2018.5F
06/30/2012	

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PART V, CLOSURE UNIT 25 PERMIT CONDITIONS
PUREX STORAGE TUNNELS

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PART V, CLOSURE UNIT 25 PERMIT CONDITIONS
PUREX STORAGE TUNNELS

UNIT DESCRIPTION

The Plutonium Uranium Extraction Facility (PUREX) Storage Tunnels are mixed waste storage units consisting of two underground railroad tunnels: Tunnel Number 1, designated 218-E-14, and Tunnel Number 2, designated 218-E-15. This Chapter sets forth the operating Conditions for this Treatment, Storage, and Disposal (TSD) unit.

CLOSURE UNIT 25

Chapter 1.0	Part A Form, dated December 17, 2018
Chapter 3.0	Waste Analysis Plan, dated December 17, 2018
Chapter 4.0	Process Information, dated December 17, 2018
Chapter 11.0	Closure and Financial Assurance, dated ~~February 28~~December 31, 2019
Addendum E	Security, dated September 30, 2010
Addendum F	Preparedness and Prevention, dated December 17, 2018
Addendum G	Personnel Training, dated June 30, 2012
Addendum I	Inspection Requirements, dated December 17, 2018
Addendum J	Contingency Plan, dated December 17, 2018

V.25.A COMPLIANCE WITH UNIT SPECIFIC PERMIT CONDITIONS

V.25.A.1 The Permittees will comply with all conditions in this Chapter and its addenda and chapters with respect to storage of waste in the miscellaneous units, (PUREX Storage Tunnels), in addition to applicable requirements in Permit Parts I and II.

V.25.A.2 In the event that the Part V, Unit Specific Conditions for Closure Unit 25, PUREX Storage Tunnels conflict with the Part I, Standard Conditions and/or Part II, General Facility Conditions of the Permit, the unit specific conditions for Closure Unit 25, PUREX Storage Tunnels prevail.

V.25.B UNIT SPECIFIC CONDITIONS

V.25.B.1 Portions of Permit Attachment 4, *Hanford Emergency Management Plan*, (DOE/RL-94-02) that are not made enforceable by inclusion in the applicability matrix for that document are not made enforceable by reference in this document.

V.25.B.2 The Permittees will comply with all requirements set forth in the Chapter 11, Closure and Financial Assurance for the PUREX Storage Tunnels, and close the PUREX Storage Tunnels in accordance with the Chapter 11, Closure and Financial Assurance. [WAC 173-303-610(3)(a)]

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PUREX STORAGE TUNNELS
CHAPTER 11.0
CLOSURE AND FINANCIAL ASSURANCE

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
02/28/2019	PCN-PUREX-2019-01
12/17/2018	8C.2018.5F
10/2006	

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CHAPTER 11.0
CLOSURE AND FINANCIAL ASSURANCE

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CHAPTER 11.0
CLOSURE AND FINANCIAL ASSURANCE

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11.0 CLOSURE AND FINANCIAL ASSURANCE

This addendum details closure activities for the Plutonium Uranium Extraction (PUREX) Storage Tunnels Operating Unit Group 2. This Operating Unit Group consists of Tunnel Number 1 and Tunnel Number 2 Dangerous Waste Management Units (DWMUs).

11.1 Introduction

The PUREX Storage Tunnels are permitted and managed as *Resource Conservation and Recovery Act of 1976* (RCRA) miscellaneous units; however, the tunnels are no longer in active operation. In May 2017, workers discovered a portion of Tunnel Number 1 had collapsed, prompting an immediate response action to protect workers and the environment. A structural evaluation revealed the threat of further failure of Tunnel Number 1. An interim stabilization measure to fill Tunnel Number 1 with engineered grout was taken under Section J.4.5 of the PUREX Tunnels Contingency Plan and Permit Condition V.25.A.1 of the Hanford Facility RCRA Permit. Grouting in Tunnel Number 1 was completed in November 2017. Filling the tunnel void spaces with grout improved tunnel stability, provided additional radiological protection, and increased durability while not precluding final closure actions. Tunnel Number 1 will receive no new waste and will continue to store the existing encapsulated waste until final closure.

At the same time, a structural evaluation also revealed the threat of future failure of Tunnel Number 2. To protect stored waste containers from potential damage caused by a tunnel failure event (e.g., puncture of a container by a falling structural member) and to prevent any associated release of dangerous waste constituents to the environment, an interim closure action to cover the stored waste and fill Tunnel Number 2 void spaces around the waste with engineered grout is being taken. No waste has been added to Tunnel Number 2 since 1996 and no waste will be added or removed, nor will personnel entry be permitted prior to grouting because of the threat of structural failure. Following implementation of the interim closure action, Tunnel Number 2 will store encapsulated waste until final closure.

Interim closure activities will ensure safe storage of dangerous waste until final closure can be completed. The response action to grout Tunnel Number 1 serves as the interim closure action for Tunnel Number 1 and is described in Section 11.5.5. Interim closure of Tunnel Number 2 will be completed in accordance with the activities described in Section 11.5.6. Following completion of the interim closure activities, an extended closure period will commence and the tunnels will be monitored and maintained until final closure. Final closure activities will be completed concurrent with remediation of the PUREX Plant as described in Section 11.6.

11.2 Facility Contact Information

PUREX Operator and Property Owner:
Doug S. Shoop, Manager
U.S. Department of Energy, Richland Operations Office
P.O. Box 550
Richland, WA 99352
(509) 376-7395

PUREX Co-Operator:
L. Ty Blackford, President and Chief Executive Officer
CH2M HILL Plateau Remediation Company
P.O. Box 1600
Richland, WA 99352
(509) 373-0293

11.3 Facility Description

The PUREX Plant is located in the southeast portion of the 200 East Area. The PUREX Plant was used for the recovery of uranium and plutonium from irradiated reactor fuel. The PUREX Plant was built in 1956 and operated until 1972. It was restarted in 1983 and operated until 1989.

The PUREX Storage Tunnels are permitted as miscellaneous units under Washington Administrative Code (WAC) 173-303-680, but are no longer in active operation and comprise Closing Unit Group 25.

Both tunnels are planned for closure, and no new waste will be accepted for placement into the tunnels.

PUREX Tunnel Number 1. Construction of PUREX Storage Tunnel Number 1 was completed in 1956. Tunnel Number 1 is approximately 5.8 meters (19 feet) wide by 6.7 meters (22 feet) high by 109 meters (358 feet) long and provides storage space for eight railcars. The maximum process design capacity for storage in Tunnel Number 1 is approximately 4,129 cubic meters (5,400 cubic yards). The tunnel experienced a partial roof collapse in May 2017. An interim stabilization was taken, and the tunnel was filled with grout in October and November 2017.

PUREX Tunnel Number 2. Construction of PUREX Storage Tunnel Number 2 was completed in 1964. The storage area of Tunnel Number 2 is approximately 5.8 meters (19 feet) wide by 6.7 meters (22 feet) high by 514.5 meters (1,688 feet) long and provides storage space for 40 railcars. The maximum process design capacity for storage in Tunnel Number 2 is approximately 19,878 cubic meters (26,000 cubic yards). Due to the potential of roof collapse, the tunnel will be interim closed by grout filling of the waste in 2018.

Diagrams of the layout of Tunnel Numbers 1 and 2 are shown in the PUREX Storage Tunnels Part A.

11.3.1 Maximum Waste Inventory

The PUREX Tunnels currently store eight railcars in Tunnel Number 1 and 28 railcars in Tunnel Number 2. The waste volume in Tunnel Number 1 is approximately 596 cubic meters (780 cubic yards). The waste volume in Tunnel Number 2 is approximately 2,204 cubic meters (2,883 cubic yards). This is the maximum waste inventory as no additional waste will be stored.

11.4 Closure Performance Standards

Closure performance standards for final closure of the PUREX Storage Tunnels will be based on WAC 173-303-610(2)(a)(i)-(iii), which requires closure of the facility in a manner that accomplishes the following objectives:

- Minimizes the need for further maintenance.
- Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere.
- Returns the land to the appearance and use of surrounding land areas, to the degree possible, given the nature of the previous dangerous waste activity.

Annual surveillance of the PUREX Storage Tunnels will be conducted as described in Addendum I, *Inspection Requirements.* During the closure period until final closure activities are conducted, the miscellaneous unit performance standards identified in WAC 173-303-680(2)(b)(i) through (4), as required by WAC 173-303-610(2)(b), will apply. Compliance with these standards is addressed in Table 11.1.

11.4.1 Closure Decision

This closure plan describes interim closure actions through the filling of the PUREX Storage Tunnels DWMUs with grout. The final closure decision for the PUREX Tunnels DWMUs has not been made, and will be made together with the remedial actions decisions for the 200-CP-1 Operable Unit. There are two options for closure of the PUREX Tunnels:

1. Clean Closure. For more detailed description of clean closure of the PUREX Tunnels, see Section 11.6.1. Clean closure requires removal of all waste and confirmation of clean closure levels for the dangerous waste constituents. The grout will cure to a strength to provide structural support in less than 24 hours. After 28 days, the grout will have a minimum strength of 1200 to 2000 pounds per square inch and could be cut with a diamond wire saw or other technology to enable removal of the equipment. The clean closure levels will be adopted from the Record of Decision (ROD) for the 200-CP-1 Operable Unit.
2. Landfill Closure. For more detailed description of landfill closure of the PUREX Tunnels, see Section 11.6.2. Landfill closure leaves waste in place and requires that a final cover is constructed over the landfill. The cover design must meet the standards in WAC 173-303-806(4)(h)(v) and WAC 173-303-665(6)(a). In addition, the permittees must comply with all the post-closure requirements in WAC 173-303-665(6)(b).

It should be noted that the closure decision is made on a DWMU level. Thus, a different closure decision can be made for each of the PUREX Tunnels.

11.5 Interim Closure Activities

The following sections describe activities supporting closure of the PUREX Storage Tunnels.

11.5.1 Training Requirements

Training requirements are described in Hanford Facility RCRA Permit (WA7890008967), Attachment 5, *Hanford Facility Personnel Training Program*, and PUREX Storage Tunnels Addendum G, *Personnel Training*.

11.5.2 Security

Located within the 200 Area of the Hanford Facility, the PUREX Storage Tunnels must comply with access control and warning sign requirements pursuant to WAC 173-303-310. Hanford Facility access is controlled by 24-hour surveillance as described in the Hanford Facility RCRA Permit (WA7890008967) Attachment 3, *Security*, and PUREX Storage Tunnels Addendum E, *Security.*

11.5.3 Preparedness, Prevention, and Emergency Procedures

PUREX Storage Tunnels preparedness, prevention, and emergency procedures are described in Hanford Facility RCRA Permit (WA7890008967) Attachment 4, *Hanford Emergency Management Plan* (DOE/RL-94-02), and PUREX Storage Tunnels Addendum F, *Preparedness and Prevention.*

11.5.4 Inspections

To prevent threats to human health and the environment during the extended closure period, the PUREX Storage Tunnels will be inspected in accordance with WAC 173-303-320(2). Inspections will be performed as described in Addendum I, *Inspection Requirements*, until the final closure certification is approved by Ecology.

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Table 11.1. WAC 173-303-680(2) through (4) Requirements

Requirement	Method of Compliance
(2) Environmental performance standards. A miscellaneous unit must be located, designed, constructed, operated, maintained, and closed in a manner that will ensure protection of human health and the environment. Permits for miscellaneous units are to contain such terms and provisions as necessary to protect human health and the environment, including, but not limited to, as appropriate, design and operating requirements, detection and monitoring requirements, and requirements for responses to releases of dangerous waste or dangerous constituents from the unit. Permit terms and provisions must include those requirements in WAC 173-303-630 through 173-303-670, 40 CFR Subparts AA through CC, which are incorporated by reference at WAC 173-303-690 through 173-303-692, WAC 173-303-800 through 173-303-806, 40 CFR, Part 63 Subpart EEE (which is incorporated by reference at WAC 173-400-075(5)(a)), and 40 CFR, Part 146 that are appropriate for the miscellaneous units being permitted. Protection of human health and the environment includes, but is not limited to:	The PUREX Storage Tunnels will be managed and monitored in a manner that will ensure protection of human health and the environment.
(a) Prevention of any releases that may have adverse effects on human health or the environment due to migration of wastes constituents in the groundwater or subsurface environment, considering: (i) The volume and physical and chemical characteristics of the waste in the unit, including its potential for migration through soil, liners, or other containing structures; (ii) The hydrologic and geologic characteristics of the unit and the surrounding area; (iii) The existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater; (iv) The quantity and direction of groundwater flow; (v) The proximity to and withdrawal rates of current and potential groundwater users; (vi) The patterns of land use in the region; (vii) The potential for deposition or migration of waste constituents into subsurface physical structures, and into the root zone of food-chain crops and other vegetation;	The interim closure activity to grout the PUREX Storage Tunnels will prevent migration of dangerous waste constituents to the groundwater or subsurface environment below the tunnels during the extended closure period.

Table 11.1. WAC 173-303-680(2) through (4) Requirements

Requirement	Method of Compliance
(viii) The potential for health risks caused by human exposure to waste constituents; and (ix) The potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.	
(b) Prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in surface water, or wetlands or on the soil surface considering: (i) The volume and physical and chemical characteristics of the waste in the unit; (ii) The effectiveness and reliability of containing, confining, and collecting systems and structures in preventing migration; (iii) The hydrologic characteristics of the unit and the surrounding area, including the topography of the land around the unit (iv) The patterns of precipitation in the region; (v) The quantity, quality, and direction of groundwater flow; (vi) The proximity of the unit to surface waters; (vii) The current and potential uses of nearby surface waters and any water quality standards established for those surface waters; (viii) The existing quality of surface waters and surface soils, including other sources of contamination and their cumulative impact on surface waters and surface soils; (ix) The patterns of land use in the region; (x) The potential for health risks caused by human exposure to waste constituents; and (xi) The potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.	The interim closure activity to grout the PUREX Storage Tunnels will prevent migration of dangerous waste constituents to the soil under the tunnels. There are no surface waters or wetlands near the PUREX Storage Tunnels.
(c) Prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air, considering: (i) The volume and physical and chemical characteristics of the waste in the unit, including its potential for the emission and dispersal of gases, aerosols and	The interim closure activity to grout the PUREX Storage Tunnels will prevent migration of dangerous waste constituents to the air outside of the tunnels. During grouting, contamination control methods, such as

Table 11.1. WAC 173-303-680(2) through (4) Requirements

Requirement	Method of Compliance
particulates; (ii) The effectiveness and reliability of systems and structures to reduce or prevent emissions of dangerous constituents to the air; (iii) The operating characteristics of the unit; (iv) The atmospheric, meteorologic, and topographic characteristics of the unit and the surrounding area; (v) The existing quality of the air, including other sources of contamination and their cumulative impact on the air; (vi) The potential for health risks caused by human exposure to waste constituents; and (vii) The potential for damage to domestic animals, wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents.	plastic sleeving, will be used when penetrations to the tunnel are opened. As the grout flows into placement locations, air will be displaced by the grout. Portable ventilation systems described in Sections 11.5.5.3.3 and 11.5.6.3 collect and filter the displaced air to prevent the spread of contamination to the environment.
(3) Monitoring, analysis, inspection, response, reporting, and corrective action. Monitoring, testing, analytical data, inspections, response, and reporting procedures and frequencies must ensure compliance with subsection (2) of this section, WAC 173-303-320, 173-303-340(1), 173-303-390, and 173-303-64620 as well as meet any additional requirements needed to protect human health and the environment as specified in the permit.	The stabilized tunnels will be maintained in a manner that prevents threats to human health and the environment and monitored through routine radiation surveillances, using radiation as an indication of contamination outside the stabilized tunnels. • Inspections required by WAC 173-303-320 are conducted as described in Addendum I. • Preparedness and Prevention measures required by WAC 173-303-340(1) are described in Addendum F. • Facility Reporting required by WAC 173-303-390 is met in accordance with Hanford Facility RCRA Permit Conditions I.E.22 and II.B. • There have been no releases from the PUREX Storage Tunnels subject to Corrective Action requirements from WAC 173-303-64620.

Table 11.1. WAC 173-303-680(2) through (4) Requirements

Requirement	Method of Compliance
(4) Post-closure care. A miscellaneous unit that is a disposal unit must be maintained in a manner that complied with subsection (2) of this section during the post-closure care period. In addition, if a treatment or storage unit has contaminated soils or groundwater that cannot be completely removed or decontaminated during closure, then that unit must also meet the requirements of subsection (2) of this section during post-closure care. The post-closure plan under WAC 173-303-610(8) must specify the procedures that will be used to satisfy this requirement.	A post-closure plan will be developed if required depending on the final closure option selected.

11.5.5 Interim Closure of Tunnel Number 1

The response action to grout Tunnel Number 1 in accordance with Section J.4.5 of the PUREX Storage Tunnels Contingency Plan and Permit Condition V.25.A.1 of the Hanford Facility RCRA Permit serves as the interim closure action for Tunnel Number 1 and is described in the following sections. The tunnel will be monitored and maintained during an extended closure period until final closure. Final closure activities will be completed concurrent with remediation of the PUREX Plant as described in Section 11.6.

11.5.5.1 Interim Response Activities

On May 9, 2017, workers discovered a collapse in a portion of the Tunnel 1 wood timber roof structure resulting in a hole approximately 5.8 meters (19 feet) wide by 5.2 meters (17 feet) long. Immediate and follow-on actions included the following:

- The Emergency Operations Center was activated to manage the immediate response to the event, including response actions necessary to protect personnel (May 9).
- Informational notification was made to Ecology that the RCRA contingency plan was being implemented, although no evidence of release from the unit was found (May 9).
- Fifty-three truckloads of soil fill were placed through the roof opening at the collapsed area to provide contamination control, shielding, protection from ambient conditions, and stabilization of the tunnel support walls (May 10).
- A temporary protective cover was installed over the full length of Tunnel 1 (May 20).
- A 15-day report was prepared and submitted to Ecology in compliance with Permit Condition II.A.1 because the contingency plan was implemented (May 24).
- United States Department of Energy (USDOE) notified Ecology of its plan to address the significant threat of further failure of Tunnel Number 1 by void filling the tunnel with grout (May 31).
- Ecology approved the plan to grout Tunnel Number 1 as an interim stabilization measure for the tunnel structure that will not preclude future closure or remedial decisions (June 8).
- Grouting was initiated on October 2 and completed on November 11.

The response action taken under the contingency plan performed the steps necessary to achieve interim closure of Tunnel Number 1. The response action stabilized contaminated equipment by filling the tunnel with engineered grout to improve tunnel stability, provide additional radiological protection, and increase durability while not precluding any final closure actions. The following sections describe the technical details of the response action taken for Tunnel Number 1.

11.5.5.2 Records Review

The structural evaluation conducted for Tunnel Number 1 reviewed tunnel drawings and specifications as well as structural properties of the tunnel components and adjacent soil. The structural evaluation is described in Chapter 4, *Process Information*, Appendix 4A. Tunnel inventory as described in Chapter 3, *Waste Analysis Plan*, was also reviewed to identify dangerous waste constituents within Tunnel Number 1.

11.5.5.3 Site Preparation and Modifications Made Prior to Stabilization

Figure 11.1 and Figure 11.2 show the layout and location for the grouting equipment in relation to Tunnel Number 1. The piping system for grout injection was placed at the location of the roof collapse. Two systems were provided, one servicing the south section of the tunnel (area from the location of the roof opening where fill soil was added to the southern end of the tunnel) and one servicing the north section. The individual pipes in each system were inserted into the top of the soil mound and routed underneath the existing roof timbers bordering each side of the collapsed roof area. The mechanism for insertion of the pipes was developed by mockup testing. Once the pipes were inserted, this area was backfilled with soil to provide a 4 foot (nominal) covering over the area. The existing 4-inch and 1.5-inch-diameter tunnel roof penetrations were used for camera and lighting placement.

11.5.5.3.1 Piping System

Figure 11.3, Figure 11.4, and Figure 11.5 illustrate detail for the piping systems. Two systems were required, one to service the north section of the tunnel and one for the south section. Each system consisted of the following:

- Two 8-inch steel pipes for grouting
- One 8-inch steel pipe for camera and lighting
- One 8-inch steel pipe for passive ventilation

Each individual pipe was inserted into a box embedded in the top of the fill soil mound and routed underneath the existing roof timbers. Pipe ends terminated into the internal space of each tunnel section.

Once all piping was placed, thrust blocks of concrete were placed in the boxes, and soil was backfilled over the area to a height of 4 feet (nominal) above the top of the exiting roof timbers. Additionally, concrete and grout were poured on the outside of the boxes to prevent the soil from collapsing into the tunnel. The vertical load of the pipe was supported by the soil mound.

11.5.5.3.2 Work Platform

A work platform was placed across the east/west centerline of collapsed roof section. The work platform facilitated the grouting operation, camera/light placement, and connection of the ventilation system. Figure 11.1 and Figure 11.2 show the placement of the work platform in relation to Tunnel Number 1. Figure 11.3 provides details of the work platform. The work platform met the following requirements:

- The platform was ground supported with 45-foot clear span and a 6-foot minimum wide working area.
- The platform was designed in accordance with the 2012 International Building Code (IBC) with a uniform live loading of 100 pounds per square foot with two 1,000-pound concentrated loads applied at midspan (one on each side of the platform).
- The platform was designed for end bearing condition based on 1,500 pounds per square foot allowable soil-bearing pressure.
- The platform included a guardrail system along each side designed in accordance with 2012 IBC provisions for non-public access with openings that prevent passage of a 21-inch-diameter sphere.

11.5.5.3.3 Ventilation System

Passive ventilation was provided during the grouting operation to control contamination in accordance with the Washington Department of Health License (EU 1471 NOC 1262 for Tunnel Number 1) conditions and limitations. Figure 11.6 shows details of the high-efficiency particulate air (HEPA) filter skid and assembly. The passive ventilation HEPA filter skids were located to one side of the tunnel berm and connected to the piping vent pipe with flex hose. Displaced air from the tunnel was routed via the vent pipe through a HEPA filter. Condensate from displaced air was collected prior to the inlet of the filter.

11.5.5.4 Stabilization Activities

Grouting of Tunnel Number 1 was conducted in October and November 2017. The grout used and the actions taken to stabilize the tunnel are described in the following sections.

11.5.5.4.1 Grout Design

During development of the grout design, the Waste Encapsulation and Storage Facility (WESF) Hot Cell A through F grouting project was reviewed to identify lessons learned that were applicable to grouting the PUREX tunnels. The differences in how the grout was inserted and the spaces to fill proved to be the major difference between the WESF and PUREX tunnel grouting activities. The WESF grout formulation demonstrated desirable characteristics that matched tunnel grout fill design requirements. Minor modifications were made to reduce cement content while maintaining overall cementitious materials (cement plus fly ash) content to reduce compressive strength and heat of hydration while maintaining stable and uniform batching and placement behavior characteristics. The grout was tested using a mockup facility to verify performance. In addition, tests were conducted to determine when the compressive strength of a grout lift was sufficient to allow the next lift to be poured. Testing demonstrated that 1-day curing time was adequate.

The standard grout formulation used in Tunnel Number 1 was established after mockup testing and is shown in Table 11.2. The grout was a flowable, nonaggregate void-filling grout formulated to meet the functional requirements listed below.

- The grout will be able to flow easily to the extent of the tunnel length and flow into open spaces in and between rail cars and equipment.
- The grout will minimize the amount of heat generated during curing.
- The target range of minimum compressive strength is 1200 to 2000 pounds per square inch after 28 days.
- The grout will provide extended placement time (typically a minimum of 3 hours) to facilitate batching and placement during construction.

Table 11.2. Standard Grout Formulation

Constituent	Quantity (per yard)
Sand	2,105 lb
Type III cement	374 lb
Fly ash	796 lb
Water	56 gal
Viscosity-modifying admixture	60 oz
Hydration-controlling admixture	60 oz
Water-reducing admixture	22 oz
Workability-retaining admixture	22 oz

The grout will have sufficient strength to provide structural support for the Tunnel. The formula was developed to also allow it to be cut using a diamond wire saw or other technology if Clean Closure is selected as the final closure action.

Minor adjustments were made to the contents as needed based on factors such as weather conditions and location in the tunnel to achieve functional requirements. A quality assurance testing program was used to ensure that the grout used for Tunnel Number 1 complied with project specifications. Engineering and laboratory-scale testing was performed to confirm that the grout formulation met the performance criteria prior to the addition of grout to PUREX Tunnel Number 1. Field inspection and testing was performed during the grouting operation. A minimum of one set of grout samples (two cylinders) was cast and tested for every 170 cubic yards of grout placed per day. Samples were taken from randomly selected trucks. Visual inspection of each truck was performed by the structural engineer (or designated representative) to visually confirm grout flowability characteristics were consistent with grout batch test results. Testing was performed in accordance with:

- ASTM C1611, *Standard Test Method for Slump Flow of Self-Consolidating Concrete*
- ASTM C1064, *Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete*
- ASTM C138, *Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete*
- ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*

11.5.5.4.2 Evaluations Conducted During Design

The grout design process included several evaluations to determine how well the grout would perform under conditions expected at PUREX.

Over long time periods, concrete structures may degrade as a result of exposure to ionizing radiation. A conservative calculation has been performed that shows that the time frame necessary for the recognized cumulative exposure threshold associated with concrete degradation is greater than 110 years. A more realistic, yet still conservative, calculation conducted for WESF Hot Cells A through F closure shows that the time frame necessary to reach a radiation exposure of concern is in excess of 590 years (CHPRC-02499, *W-130 Project Calculation: Estimate of Impacts to Grout as a Result of Radiation Exposure*). Radiation fields in the PUREX Storage Tunnels are much lower than those encountered in the WESF Hot Cells. No significant degradation of grout due to radiation exposure in the near time frame is expected.

Grout can also be affected by exposure to high temperature. The grout design limits temperatures due to heat of hydration to 160°F, which will not negatively affect the grout or structural concrete. Potential impacts to the grout as a result of heat of hydration and decay heat have been evaluated (CHPRC-02499), and there are no deleterious effects.

11.5.5.4.3 Grout Delivery

Grout was prepared offsite and trucked to Tunnel Number 1. Figure 11.7 includes a site plan for the grouting operations. Grout samples were collected and tested during daily placements. A grout pump vehicle was placed on the west side of the tunnel entrance.

After equipment installation, the grouting was performed by connecting a grouting pipe from the grout pumping vehicle to the pipe system. Addition of the grout into each section of the tunnel displaced air from the tunnel. The displaced air was routed through a flex hose to the HEPA filter skids described in Section 11.5.5.3.3. A second skid, collocated next to the primary filter skid, served as backup.

Cameras with lighting were used to monitor the progress of the fill and to provide visual confirmation that the spaces being grouted were filled to maximum extent possible. A temporary washout pit was set up to the south of PUREX along PUREX Drive and was part of the exit route for the delivery vehicles.

11.5.5.4.4 Grout Placement

Placement of grout began at the location of the roof collapse and subsequent soil fill. This location allowed both ends of the tunnel on either side of the soil fill to be grouted from a single point. Each section of the tunnel (north and south) used a dedicated piping arrangement to facilitate grouting. The sequence for grouting is described below.

The grout in the south end of the tunnel was placed in a series of lifts to prevent the equipment on the railcars from floating. The initial pours were approximately 1 to 2 feet of grout to reach from the floor to the bottom of the railcars. The initial pours were allowed to set up before additional grout was added. Subsequent lifts locked the equipment in place on the railcars. The final additions of grout were conducted to totally encapsulate the equipment and fill the south end to the maximum extent practicable.

The grout in the north section of the tunnel was placed in 1- to 2-foot lifts. This was done to capture the equipment on the rail cars and also to limit the hydraulic pressure on the seals of the water-fillable door. The grout additions continued in small increments until all of the equipment was covered in grout and the north section was filled to the maximum extent practicable.

Grout was distributed from the grout pump vehicle located west of the tunnel. Valves were used at the fill connections to enable quick shutoff of grout once the volume is filled. As grout flowed into the tunnel, air was displaced by the grout. The displaced air contained water vapor and was considered potentially radioactively contaminated. To control contamination during grouting, portable ventilation systems, described in Section 11.5.5.3.3, were used to collect and filter the displaced air. A total of 4,396 cubic yards of grout was placed into Tunnel 1. This totally encapsulated the equipment to within approximately 6 inches from the roof timbers.

The work platform and ventilation equipment were removed after grouting was completed and soil fill was placed in the area to match the profile of existing tunnel soil cover. The piping system and camera and lighting components added on to the existing tunnel penetrations were abandoned in place.

11.5.6 Interim Closure of Tunnel Number 2

Interim closure of Tunnel Number 2 will be completed as described in the following sections. Following completion of interim closure, an extended closure period will commence and the tunnel will be monitored and maintained until final closure.

11.5.6.1 Records Review

The structural evaluation conducted for Tunnel Number 2 reviewed tunnel drawings and specifications as well as structural properties of the tunnel components and adjacent soil. The structural evaluation is described in Chapter 4, *Process Information*, Appendix 4B. Tunnel inventory as described in Chapter 3, *Waste Analysis Plan*, was also reviewed to identify dangerous waste constituents within Tunnel Number 2.

11.5.6.2 Site Preparation

The Tunnel Number 2 area will be prepared to enable the safe insertion of the engineered grout while limiting the risks to the workers and the environment. Roads required for the grout trucks will be prepared to provide a stable platform to deliver the grout. The path of the trucks will be designed to limit the potential for interfering with the normal traffic patterns of the area. A site plan for Tunnel Number 2 activities is shown in Figure 11.8.

Additionally, investigative work was performed to verify the assumptions utilized in the engineering design process. This included removing a 3-inch plug in an existing 30-inch tunnel riser plug to enable samples to be taken in the interior of the tunnel and ensuring the main plug can be removed. These samples included industrial hygiene (e.g., flammable gas, volatile organics, or hazardous materials) and radiological samples to determine the status of the atmosphere and the potential for radiation exposure from both direct radiation and airborne. The 30-inch plugs on the risers that will be utilized for grout insertion were pulled and put back in place to confirm the plugs could be removed. The investigation also revealed that the length and configuration of some of the railcars was different than previously assumed. The artist's rendition of Tunnel Number 2, shown in Figure 4.2 and Figure 11.11, show the updated configuration.

11.5.6.3 Modifications Made Prior to Stabilization

Modifications will be required to prepare the tunnel for the insertion of the grout. Plugs in existing riser positions that will be utilized during the grouting process will be removed. The plug will then be replaced with an engineered replacement to allow grout insertion as well as provide locations for cameras and necessary lighting (Figure 11.9 and Figure 11.10). Work on the tunnel is being done using lifts and cranes. No work platform is required.

Additionally, a riser will be modified to connect the ventilation system to capture the air expelled from the tunnel during the grouting activities. Projected riser locations for cameras, lighting, and ventilation equipment are shown in Figure 11.11.

A passive ventilation system skid similar to that used for Tunnel Number 1 will be utilized to filter air discharged from the tunnel during grouting (Figure 11.6). The system will be designed and licensed in accordance with the Hanford Site Air Operating Permit (AOP 00-05-006).

11.5.6.4 Stabilization Activities

The stabilization activities for Tunnel Number 2 are described in the following sections. To the extent possible, materials and process used for stabilization of Tunnel Number 1 will be used for Tunnel Number 2.

11.5.6.4.1 Grout Design

The grout design that will be utilized for Tunnel Number 2 will be similar to the grout that was utilized in Tunnel Number 1 with the only difference being Type I/II cement will be utilized in Tunnel 2 instead of Type III. Functional requirements and formulation of the grout is shown in Section 11.5.5.4.1.

11.5.6.4.2 Grout Delivery

The grout will be delivered through the modified riser plugs located along the top of the tunnel. To prevent loading the top of the tunnel, the piping will be a goose-neck type delivery system located off the tunnel surface (Figure 11.12). The piping will be connected to the modified riser plug shown in Figure 11.9 and Figure 11.10 utilizing industrial concrete rubber hose. The projected location for grout insertion is shown in Figure 11.11. This will limit the load on the tunnel while enabling the grout insertion into the tunnel.

11.5.6.4.3 Grout Placement

It is estimated that Tunnel 2 will require approximately 43,000 cubic yards to stabilize. The grout will be placed in the tunnel in layers. The layers will be small enough to prevent the possibility of creating a buoyant force to lift the equipment on the railcars in the tunnel. It will be delivered in multiple locations to ensure the grout flows and covers the entire tunnel.

A ventilation skid with a passive HEPA filter system will be connected to one of the risers. This will enable the air in the tunnel to escape through a filtered media to prevent the release of airborne contamination. The skid will have equipment to collect the condensate from the system.

During the evolution to grout the tunnel, standard radiological controls will be utilized to prevent the release and/or spread of contamination. This may include the use of sleeving, glovebags, negative air machines, etc. The type of control will be selected based on the risk of the work being performed and the potential for a release. Quality control testing will be conducted during grout placement in the same manner used for Tunnel Number 1 as described in Section 11.5.5.4.1. Grout that does not meet the grout design standards listed in Section 11.5.5.4.1 will be returned to the vendor and will not be used for the tunnel.

11.6 Final Closure Activities

Final closure of the PUREX Storage Tunnels will be coordinated with closure/remediation of the PUREX Plant in accordance with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO or Tri-Party Agreement [TPA]), Section 5.5. The final closure decision for the PUREX Storage Tunnels will be deferred until the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action for the 200-CP-1 Operable Unit because the close proximity of the two facilities will impact the final disposition of each facility. Coordination of the RCRA unit closure and the CERCLA operable unit investigation and remediation is necessary to prevent overlap and duplication of work.

The CERCLA remedial investigation process will be initiated in accordance with the schedule established in TPA Milestone M-085-80. The nature and extent of contamination and alternatives to mitigate risks to human health and the environment will be evaluated in a CERCLA feasibility study.

A feasibility study evaluates alternatives for compliance with applicable or relevant and appropriate requirements, including substantive closure requirements defined in WAC 173-303-610. A CERCLA proposed plan identifies a preferred alternative for remediation and is submitted for public comment in accordance with the Hanford Public Involvement Plan (http://www.hanford.gov/files.cfm/FacAgreementand-Consent-Order_FINAL.pdf). Following consideration of public comment, a ROD documents the selected remedial alternative. A remedial design/remedial action work plan documents the design and schedule for remediation activities.

USDOE will work with Ecology to integrate the CERCLA decision information as it becomes effective into the closure plan. The final closure plan will meet the requirements of WAC 173-303-140 and WAC 173-303-610. Potential final closure options for the PUREX Storage Tunnels are described in Sections 11.6.1 and 11.6.2. These options may be modified and additional options may be developed based on the remedial investigation results and the examination of available technologies.

11.6.1 Retrieval/Clean Closure Options

As part of an interim stabilization measure in response to a collapse event discovered by workers on May 9, 2017, Tunnel Number 1 was filled with grout to improve tunnel stability, provide additional radiological protection, and increase durability while not precluding final closure actions. Because of the threat of future failure of Tunnel Number 2, interim closure activities are being taken to stabilize Tunnel Number 2 with grout.

Clean closure by retrieval could be implemented if the results of the decision-making process determine that it is practicable, protective of human health and the environment, and in compliance with applicable regulations. If clean closure is the selected option, the closure action might consider but will not be limited to the options described in Sections 11.6.1.1, 11.6.1.2, and 11.6.1.3. These options could be modified based on the remedial investigation results and the examination of available technologies.

11.6.1.1 Retrieval and Disposal in the PUREX Plant

In this option, railcars and grout in both tunnels would be retrieved after excavation of the tunnel by cutting and removal using water jets, wire saws, excavation equipment, or other technologies. A detailed excavation plan, including specific cut locations, would be developed as part of the final remediation/closure evaluation described in Section 11.6. Waste material would be moved from the tunnels to the PUREX Plant canyon deck area or an alternate location if disposal in the plant is the selected alternative. Waste such as empty railcars that could not be placed in the PUREX Plant for disposal (e.g., insufficient space) would be removed for final disposition at other approved disposal facilities.

Final disposition of the waste transferred to the plant, including characterization or size reduction as needed as well as disposition of the tunnel structure, would be completed as part of the coordination with the 200-CP-1 Operable Unit remedial action. Closure activities would be conducted in compliance with applicable WAC requirements. The excavation plan and waste disposition processes would be developed to ensure that the silver nitrate contained in Tunnel Number 2 is not exposed to conditions that would cause it to ignite and that mercury contained in Tunnel Number 2 is not released to the environment. Verification sampling would be performed in accordance with an approved sampling and analysis plan.

11.6.1.2 Retrieval and Physical Processing (Size Reduction) in the PUREX Plant and Subsequent Disposal

In this option, retrieval of waste material stored in the tunnels would be similar to that described in the previous section if physical processing in the plant and disposal elsewhere is the selected alternative in the remedial action decision for the 200-CP-1 Operable Unit. Once the waste material was transferred to the PUREX Plant canyon deck area or alternate location within the plant, characterization and size reduction of waste material would proceed as needed. An area located on the canyon deck, in a process cell, or in an alternate location would be modified to include all necessary equipment to perform characterization, size reduction, and packaging activities. Size reduction would be performed through various technologies that include but are not limited to flame cutting, water jet cutting, sawing, or other technologies.

Final disposition of the processed waste material either onsite or offsite, as well as disposition of the tunnel structure, would be completed as part of the coordination with the 200-CP-1 Operable Unit remedial action. Closure activities would be conducted in compliance with applicable WAC requirements. The excavation plan and waste disposition processes would be developed to ensure that the silver nitrate contained in Tunnel Number 2 is not exposed to conditions that would cause it to ignite and that mercury contained in Tunnel Number 2 is not released to the environment. Verification sampling would be performed in accordance with an approved sampling and analysis plan

11.6.1.3 Construction of a New Facility for Retrieval, Processing, and Treatment of Equipment for Disposal

This option involves the construction of a new facility that is either mobile or stationary to remove and treat waste material stored in the tunnels. The facility would be constructed in a manner consistent with the retrieval and handling requirements for large, contaminated waste material. Retrieval of the waste and grout from Tunnel Numbers 1 and 2 could involve cutting and removal using water jets, wire saws, excavation equipment, or other technologies. Following retrieval, treatment and disposition of the waste material, as well as disposition of the tunnel structure, would be completed as part of the coordination with the 200-CP-1 Operable Unit remedial action.

Closure activities would be conducted in compliance with applicable WAC requirements. The excavation plan and waste disposition processes would be developed to ensure that the silver nitrate contained in Tunnel Number 2 is not exposed to conditions that would cause it to ignite and that mercury contained in Tunnel Number 2 is not released to the environment. Verification sampling would be performed in accordance with an approved sampling and analysis plan.

11.6.2 In Situ Disposal (Landfill Closure)

As part of an interim stabilization measure in response to a collapse event discovered by workers on May 9, 2017, Tunnel Number 1 was filled with grout to improve tunnel stability, provide additional radiological protection, and increase durability while not precluding final closure actions. Because of the threat of future failure of Tunnel Number 2, interim closure activities are being taken to fill Tunnel Number 2 with grout.

In situ disposal (landfill closure) of Tunnel Numbers 1 and 2 could be implemented if the results of the decision-making process determine that landfill disposal of the stored waste is protective of human health and the environment and in compliance with applicable regulations. If in situ disposal (landfill closure) is the selected option, the closure action might consider but will not be limited to the option described in Section 11.6.2.1. This option could be modified based on the remedial investigation results and the examination of available technologies.

11.6.2.1 Maintain Grout and Install Landfill Cover

This option would involve maintaining the grout fill placed in Tunnel Numbers 1 and 2 as part of the interim stabilization/interim closure measures described in Sections 11.5.5 and 11.5.6. At final closure, remaining external equipment (e.g., risers or monitoring equipment) would be removed from the tunnel surface if necessary. Final closure activities would comply with applicable WAC requirements for landfill closure, including construction of a surface barrier that meets RCRA landfill cover requirements to prevent water from leaching mixed waste contained in the tunnels. Final landfill cover design and installation would be completed as part of the coordination with the 200-CP-1 Operable Unit remedial action.

11.6.3 Identifying and Managing Contaminated Media

If contaminated media removal is required during final closure, it will be managed as a newly generated waste stream in accordance with WAC 173-303-610(5). The contaminated media must be handled in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230, containerized, labeled, characterized in accordance with WAC 173-303-070 requirements, designated as a dangerous or non-dangerous waste, stored, and transported to an appropriate disposal facility. It will be treated (if necessary) to meet Land Disposal Restriction requirements in 40 CFR 268, incorporated into WAC 173-303-140(2)(a) by reference, then ultimately disposed.

11.6.4 Role of Independent Qualified Registered Professional Engineer

An independent, qualified, registered professional engineer (IQRPE) will be retained to provide certification of final closure, as required by WAC 173-303-610(6). The IQRPE will be responsible for observing field activities and reviewing documents associated with closure of the PUREX Storage Tunnels.

The IQRPE will perform a number of field activities. However, these field activities are dependent on the closure decision and will be defined when the closure decision has been made.

The IQRPE will record his or her observations and reviews in a written report that will be retained in the operating record. The resulting report will be used to develop the closure certification, which will then be provided to Ecology.

11.6.5 Certification of Closure

In accordance with WAC 173-303-610(6), within 60 days of completing final closure activities for the PUREX Storage Tunnels, certification that closure activities have been completed in accordance with the approved closure plan will be submitted to Ecology by registered mail or other means that establish proof of receipt (including applicable electronic means). The certification will be signed by the owner or operator and signed and certified by an IQRPE. Information supporting IQRPE closure certification will be submitted upon request by Ecology.

11.6.6 Conditions that will be Achieved when Closure is Complete

Depending on the final closure decision, the PUREX Storage Tunnels will be demolished, and components removed and disposed, or they will be closed as a landfill with a surface barrier that meets RCRA landfill cover requirements.

11.7 Closure Schedule and Time Frame

Preparation for and implementation of interim closure activities are being completed to target start of stabilization of Tunnel Number 2 in 2018. Final closure activities for the PUREX Storage Tunnels will take place in conjunction with the remedial actions for the PUREX Plant and the 200-CP-1 Operable Unit. It is anticipated that a number of years will elapse before remedial actions for the PUREX Plant can be initiated. The first step in the remedial action process – developing a draft remedial investigation/feasibility study work plan – is subject to TPA Milestone M-085-80.

Continued storage of dangerous waste in the tunnels will necessitate an extension to the 180 days to complete final closure activities required in WAC 173-303-610(4)(b). This extension is being requested in accordance with WAC 173-303-610(4)(b)(i). Stabilization of the PUREX Storage Tunnels with grout as described in Sections 11.5.5 and 11.5.6 mitigates the potential for exposing workers to dangerous wastes or releasing dangerous wastes into the environment until final closure can be completed.

Approval of this closure plan will grant the Hanford Facility an extended closure period for performance of final closure activities, in accordance with WAC 173-303-610(4)(b), and a separate extension request will not be filed.

During this extended closure period, the Hanford Facility will comply with all applicable requirements of the permit. Additionally, the PUREX Storage Tunnels will be maintained in a manner that prevents threats to human health and the environment. Interim closure activities will be initiated within 60 days after receipt of approved permit. Interim closure activities and extended closure period expected durations are outlined in the closure activities schedule in Table 11.3.

Table 11.3. PUREX Storage Tunnels Closure Activities Schedule

Activity Description	Expected Duration/Date
Interim Closure of Tunnel Number 2	
Preparation (construction of piping systems, ventilation system, etc.)	5 months
Grouting	6 months
Submit interim closure report	60 days after interim closure activities complete
Extended Closure Period	
Extended closure period deferring closure to be concurrent with remedial action of PUREX Plant and 200-CP-1 Operable Unit, including continued surveillance and inspection	To be determined
Initiate remedial action process (TPA M-085-80, *Submit Remedial Investigation/Feasibility Study Work Plan for 200-CP-1 to Ecology*)	9/30/2020
Implementation of final closure decision (clean closure or landfill closure)	To be determined
Completion of Closure Activities	
Submit final closure certification	60 days after final closure activities complete
Post-Closure (if required)	
Groundwater monitoring and reporting	As required by post-closure plan

Table 11.3. PUREX Storage Tunnels Closure Activities Schedule

Activity Description	Expected Duration/Date
Maintenance and monitoring of waste containment systems	As required by post-closure plan

11.8 Cost of Closure

A detailed written estimate outlining updated projections of anticipated closure costs for the Hanford Facility treatment, storage, or disposal units having final status is not required per Permit Condition II.H.

11.9 References

ASTM C39/C39M-17b, 2017, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*, ASTM International, West Conshohocken, Pennsylvania. Available at: https://www.astm.org/Standards/C39.htm.

ASTM C138/C138M-17a, 2017, *Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete*, ASTM International, West Conshohocken, Pennsylvania. Available at: https://www.astm.org/Standards/C138.htm.

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CHPRC-02499, 2015, *W-130 Project Calculation: Estimate of Impacts to Grout as a Result of Radiation Exposure*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

2012 International Building Code, International Code Council, May 2011. Available at: http://tyrone.org/wp-content/uploads/2017/05/icc.ibc_.2012.pdf.

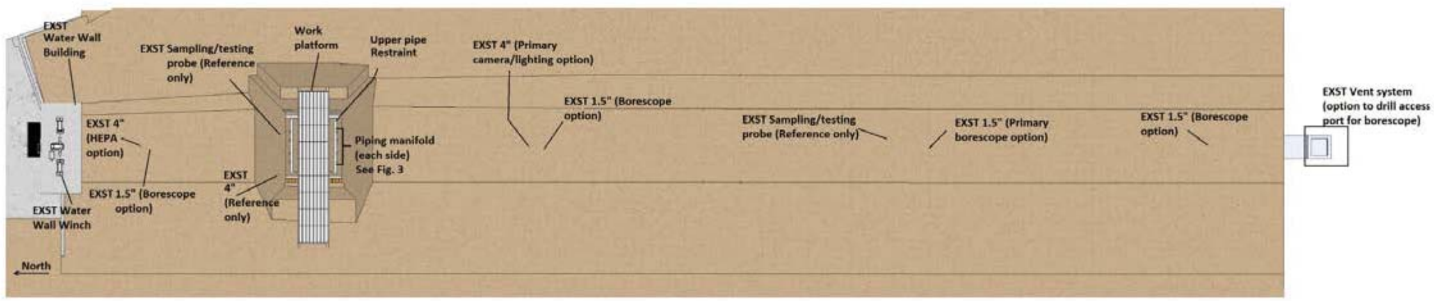

Figure 11.1. Plan View of Tunnel Number 1 with Equipment Placement and Layout

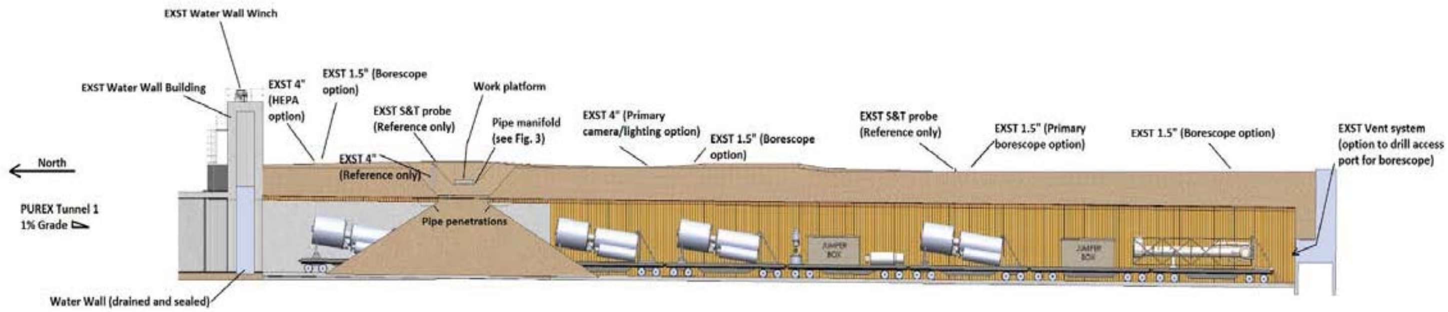

Figure 11.2. West Elevation of Tunnel Number 1 with Equipment Placement

Note: Water wall refers to the water-fillable door.

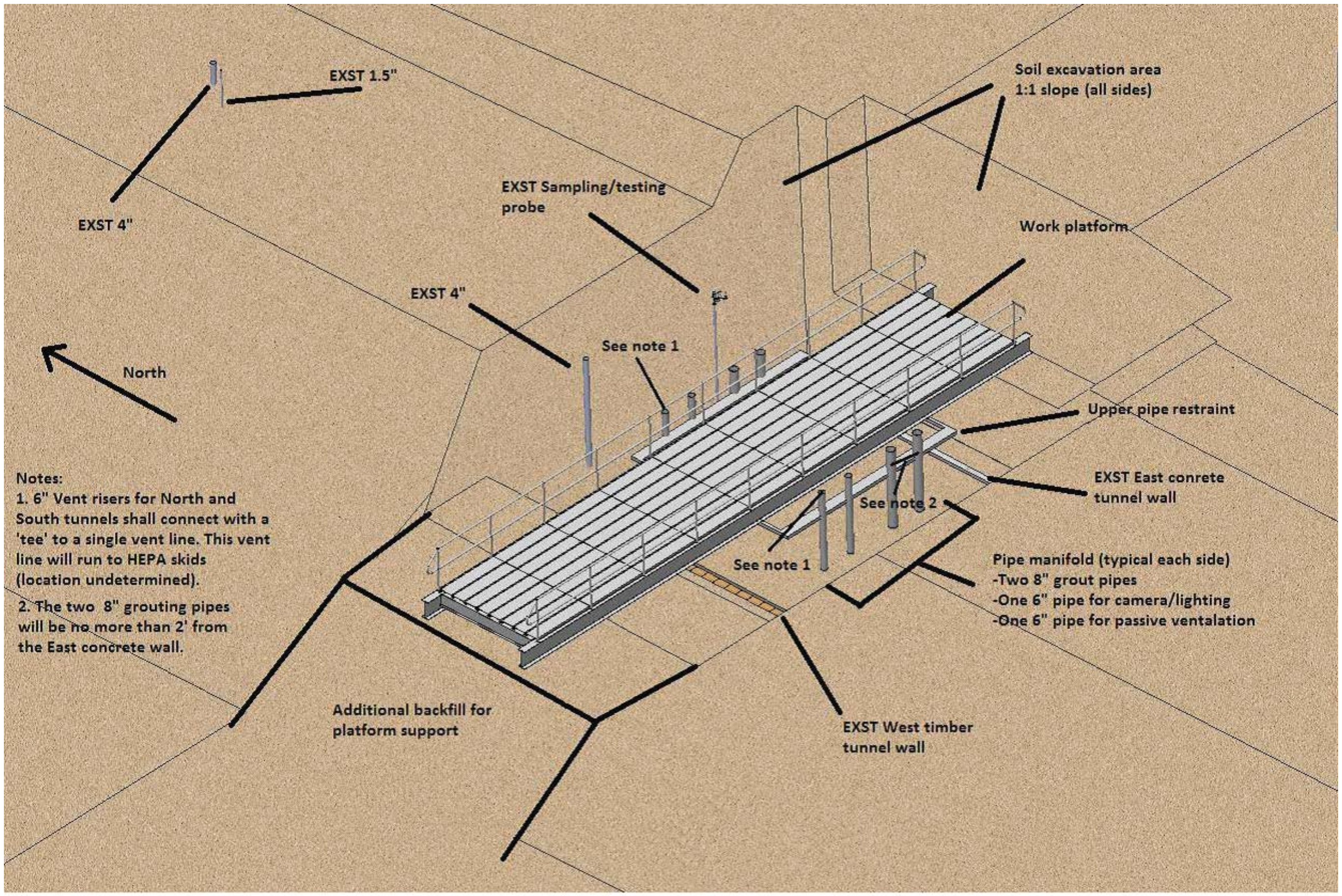

Figure 11.3. Isometric of Tunnel Number 1 Grouting Equipment – Platform and Piping Arrangement

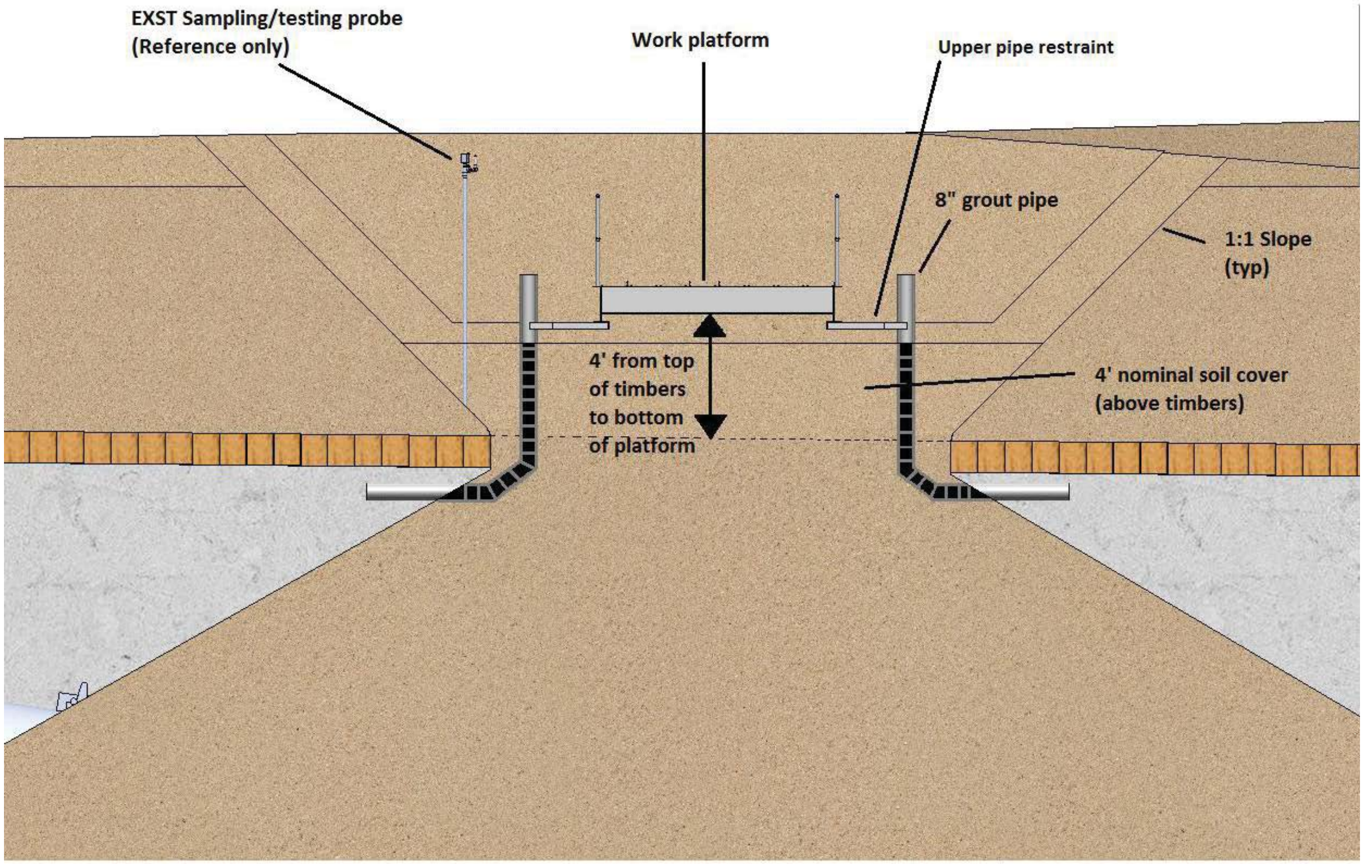

Figure 11.4. West Elevation of Tunnel Number 1 Grouting Equipment – Platform and Piping

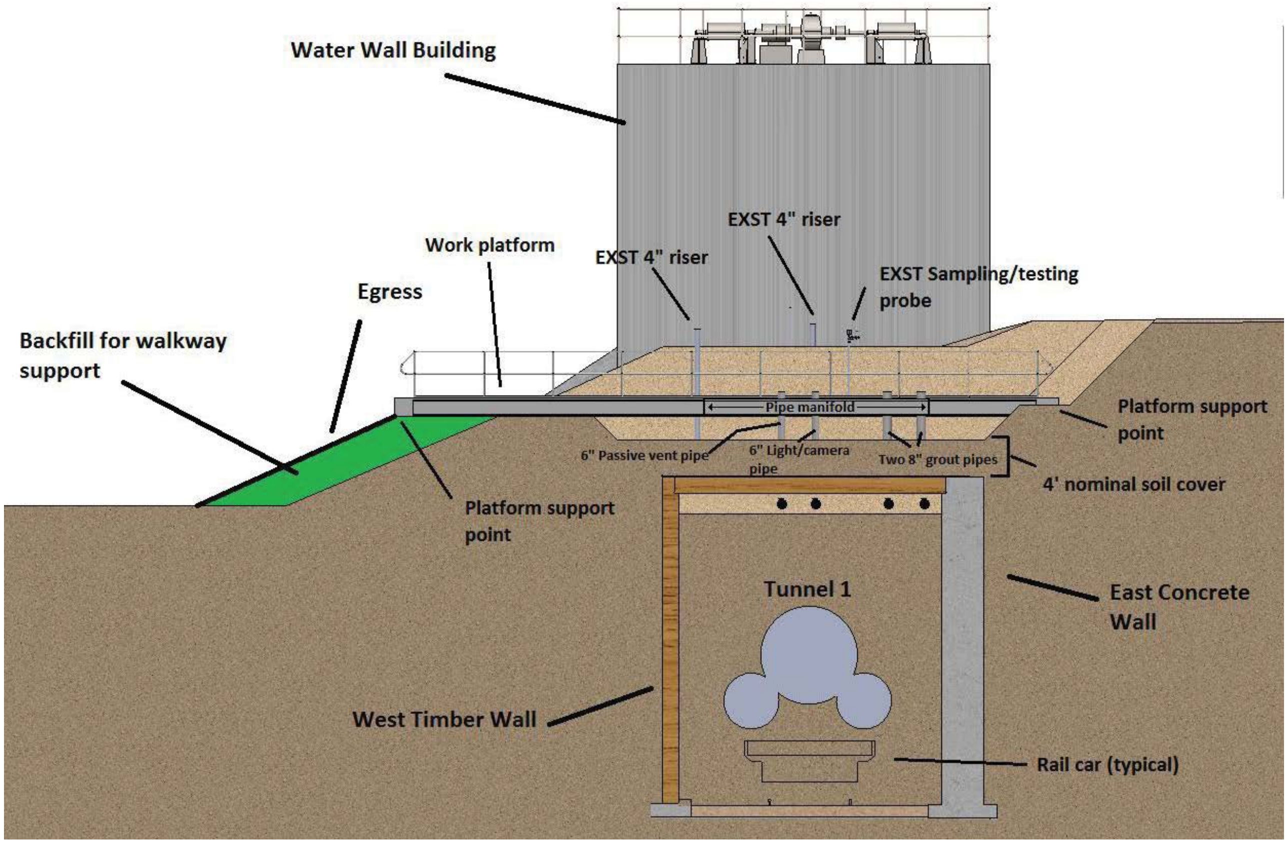

Figure 11.5. South Elevation of Tunnel Number 1 Grouting Equipment – Platform and Piping

Note: Water wall refers to the water-fillable door.

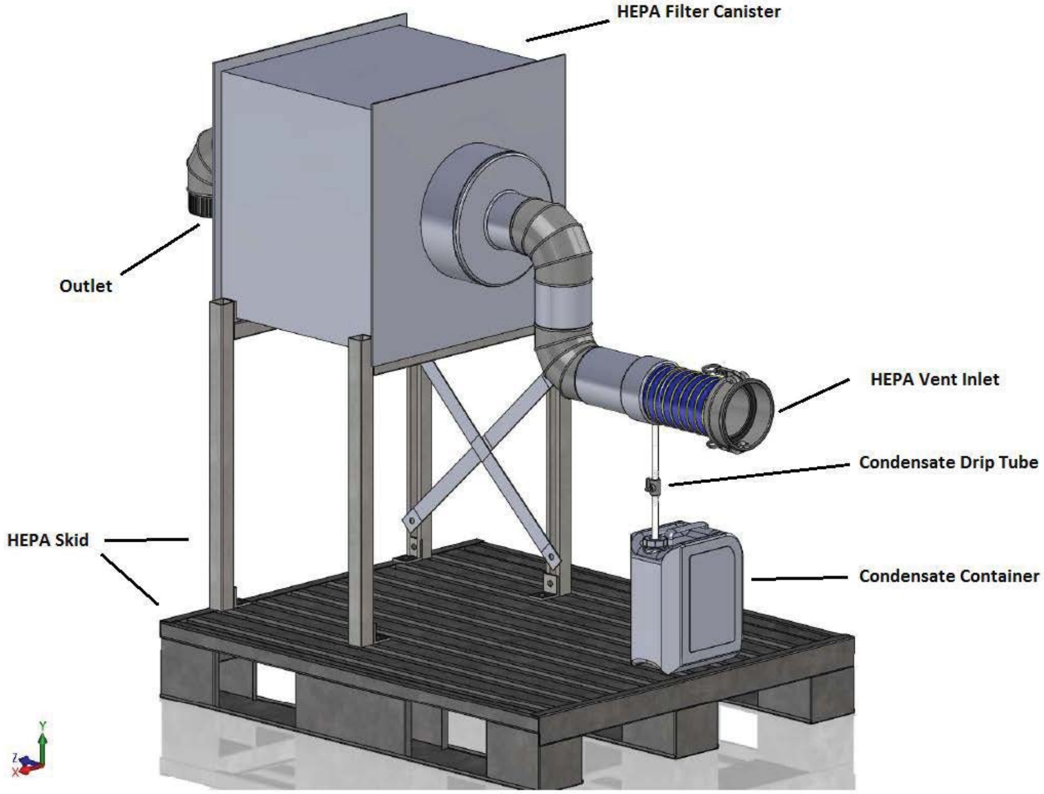

Figure 11.6. Passive Ventilation Filter Assembly for Tunnel Number 1

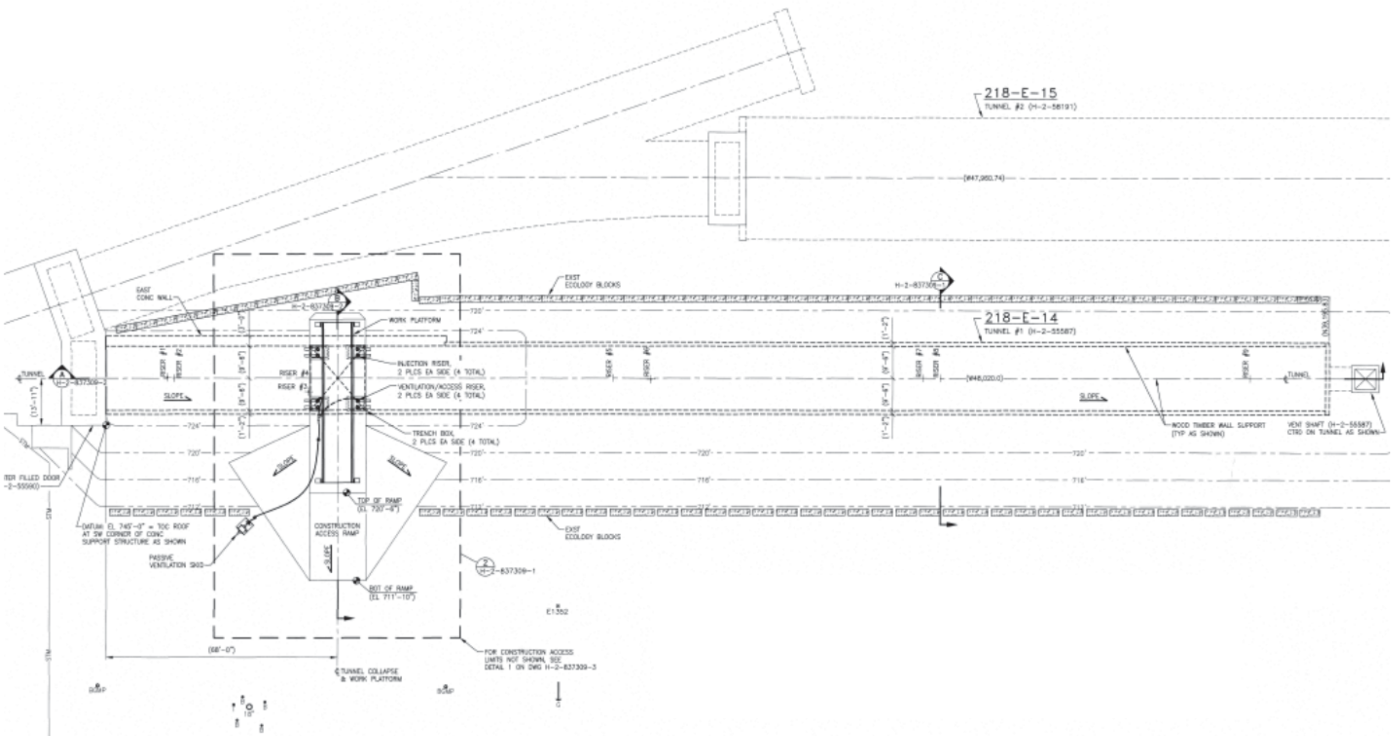

Figure 11.7. Tunnel Number 1 Site Plan

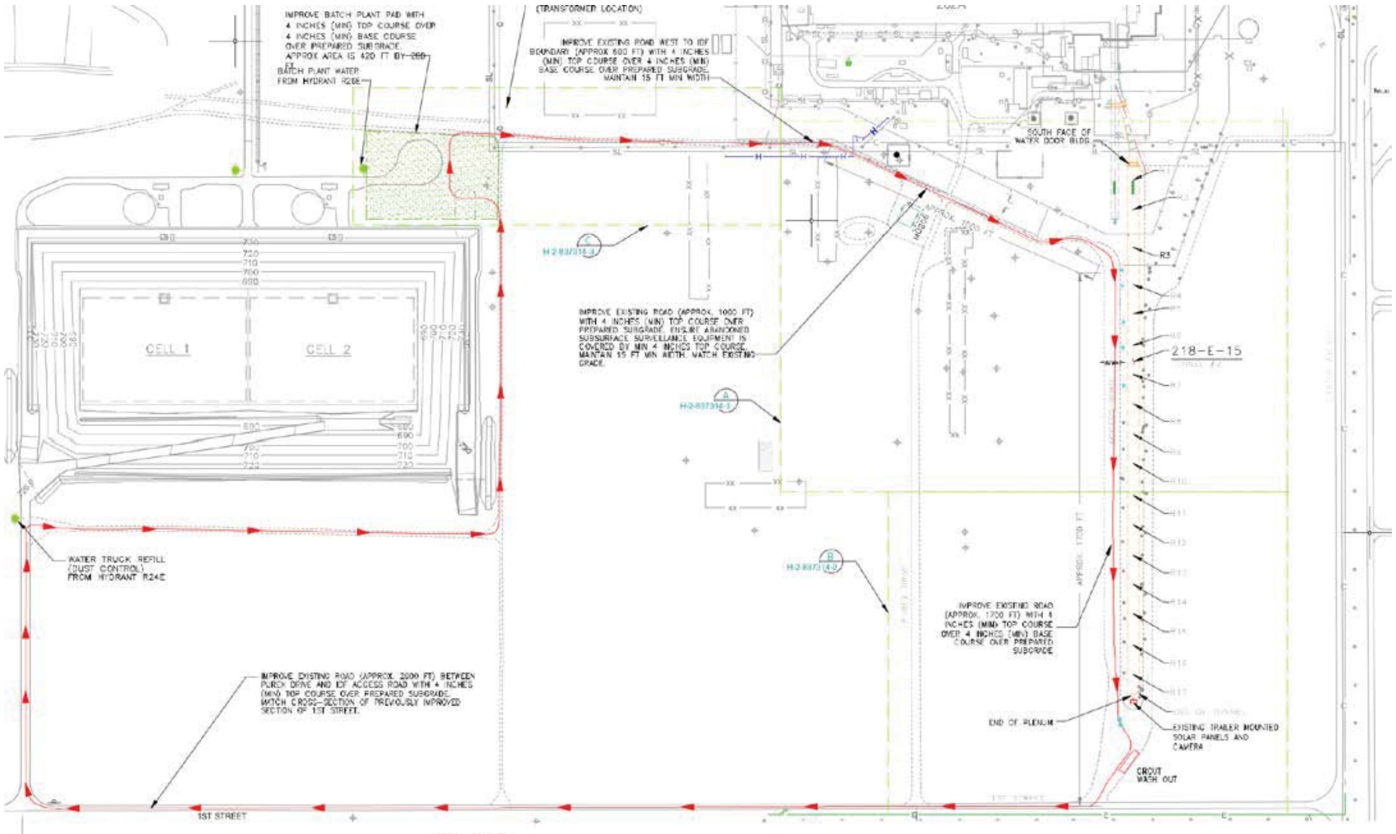

Figure 11.8. Tunnel Number 2 Site Plan

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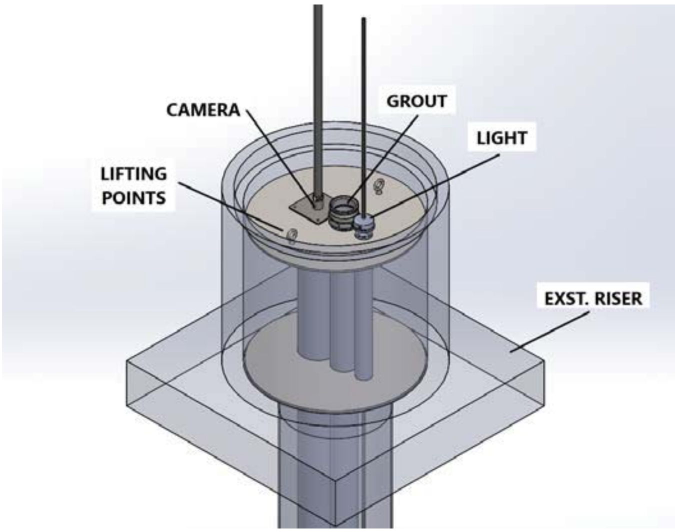

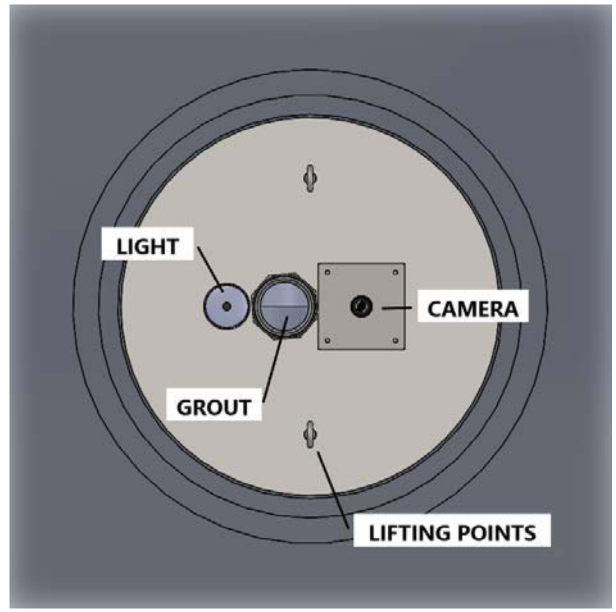

Figure 11.9. Plug Replacement for Existing Riser in Tunnel Number 2 (Isometric and Plan Views)

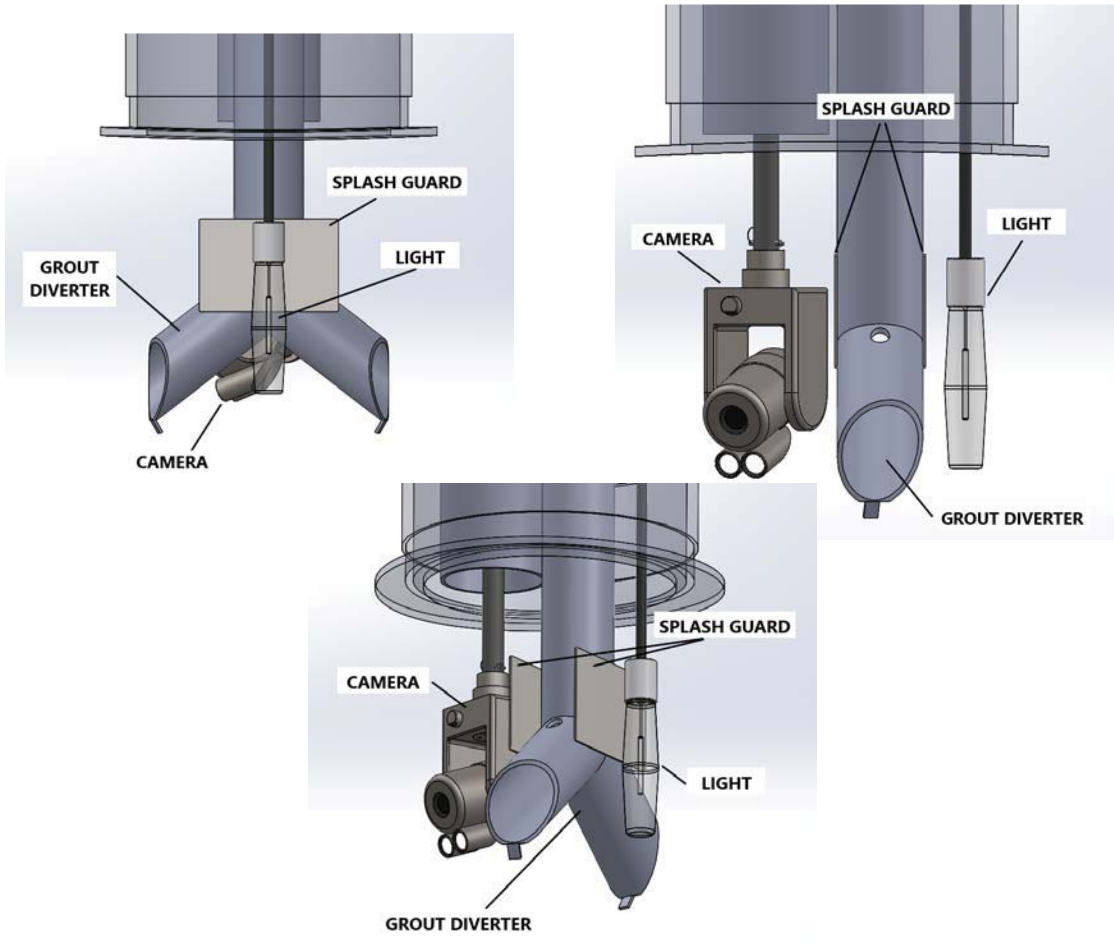

Figure 11.10. Equipment to be Deployed Through Existing Riser in Tunnel Number 2 (Two Elevations and Isometric)

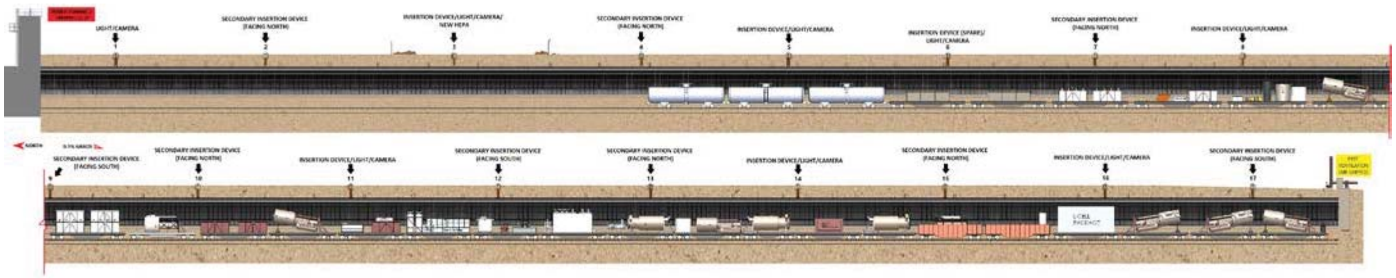

Figure 11.11. Location of Risers and Equipment for Grouting Tunnel Number 2

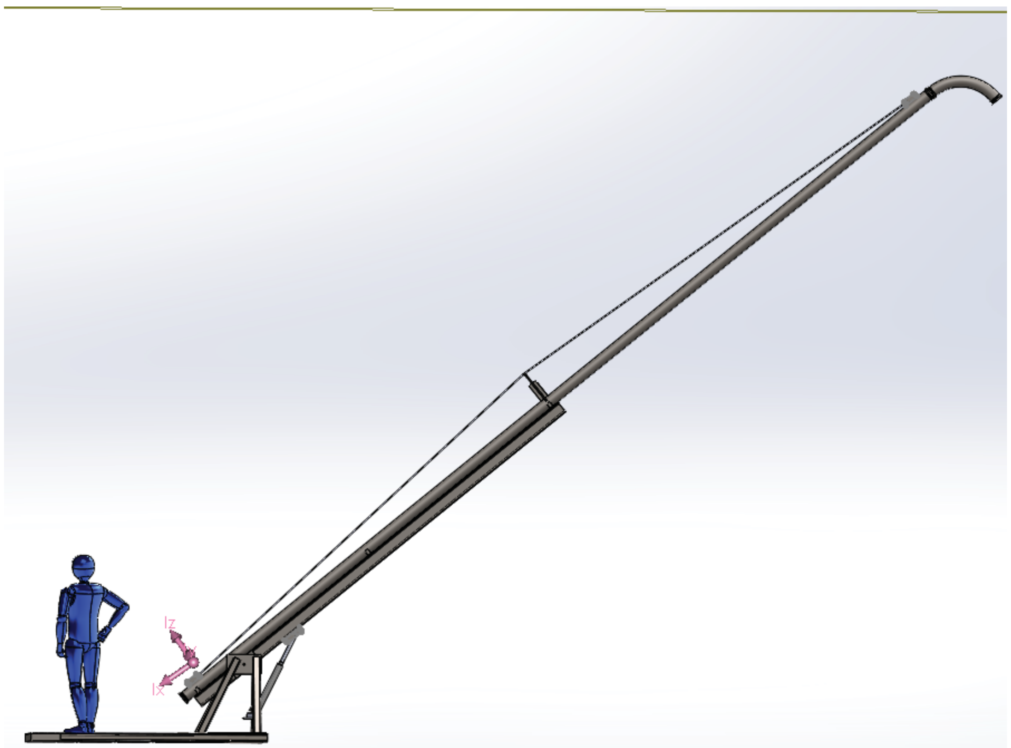

Figure 11.12. Goose-Neck Grout Delivery Piping for Tunnel Number 2

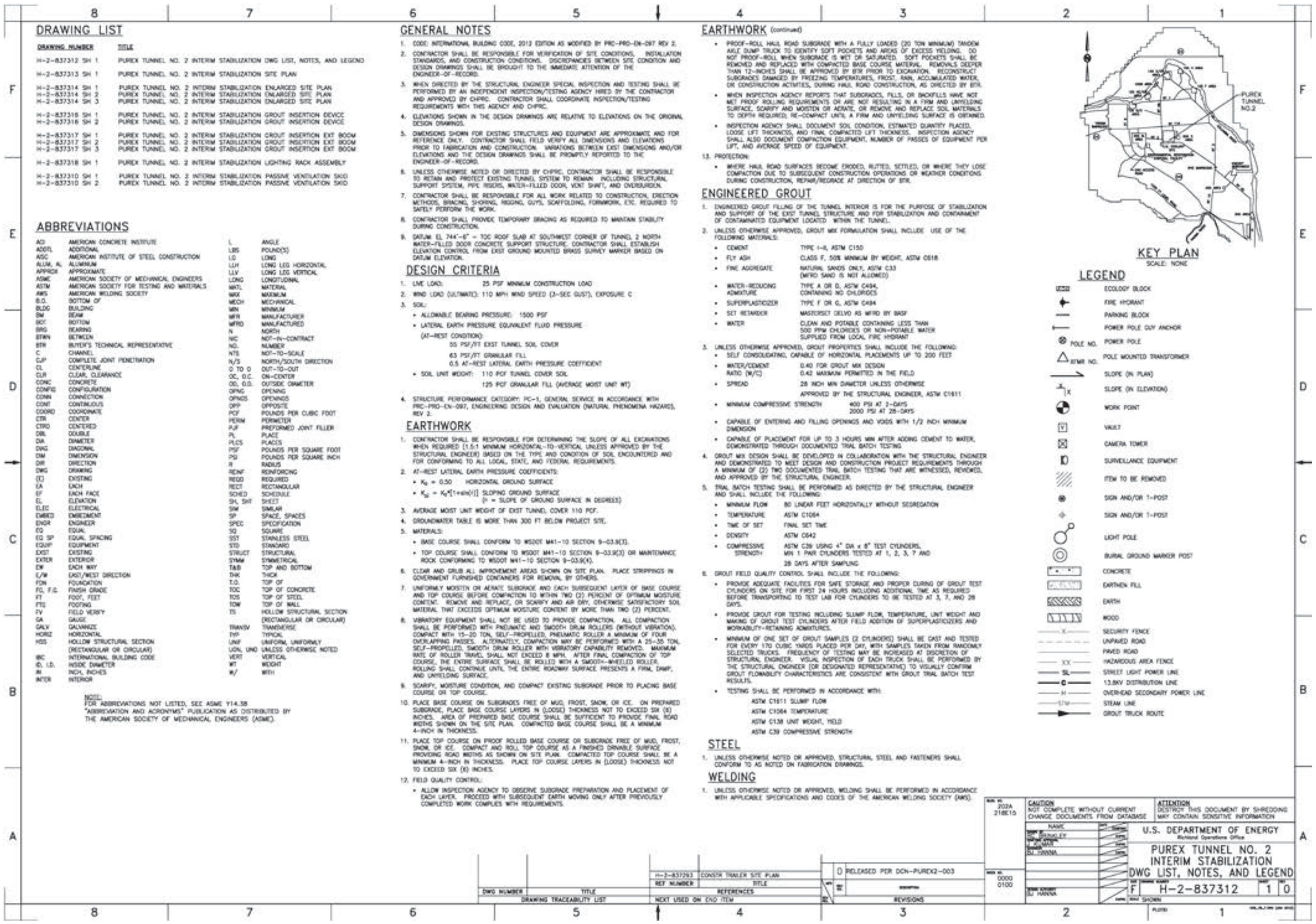

Figure 11.13. PUREX Tunnel NO. 2 Interim Stabilization Drawing List, Notes, and Legend, #H-2-837312-1

Commented [MPW-C2]: Replace this Figure with the updated Figure.

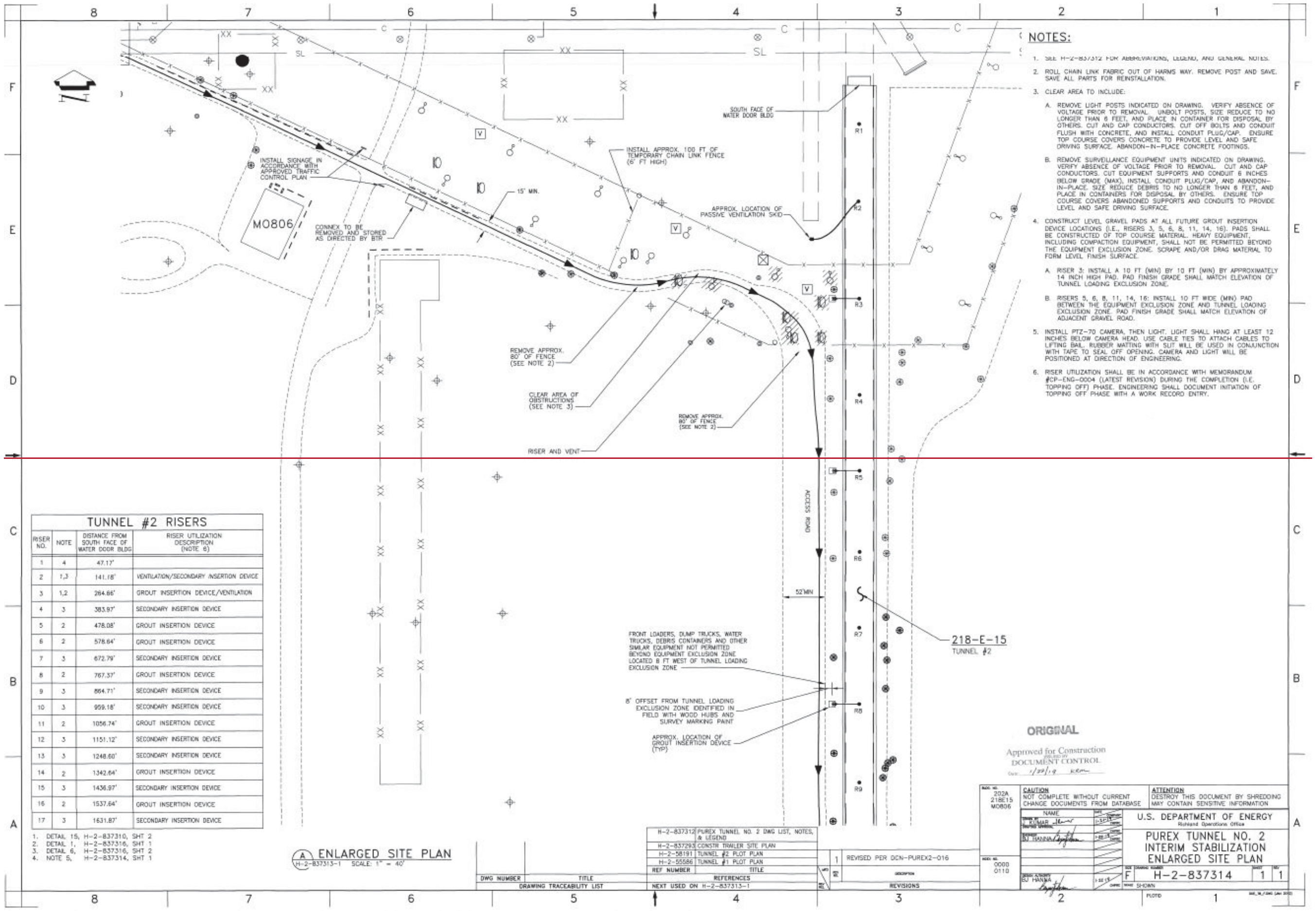

Figure 11.14. PUREX Tunnel NO. 2 Interim Stabilization Enlarged Site Plan 1, #H-2-837314-1

Commented [MPW-C3]: Replace this Figure with the updated Figure.

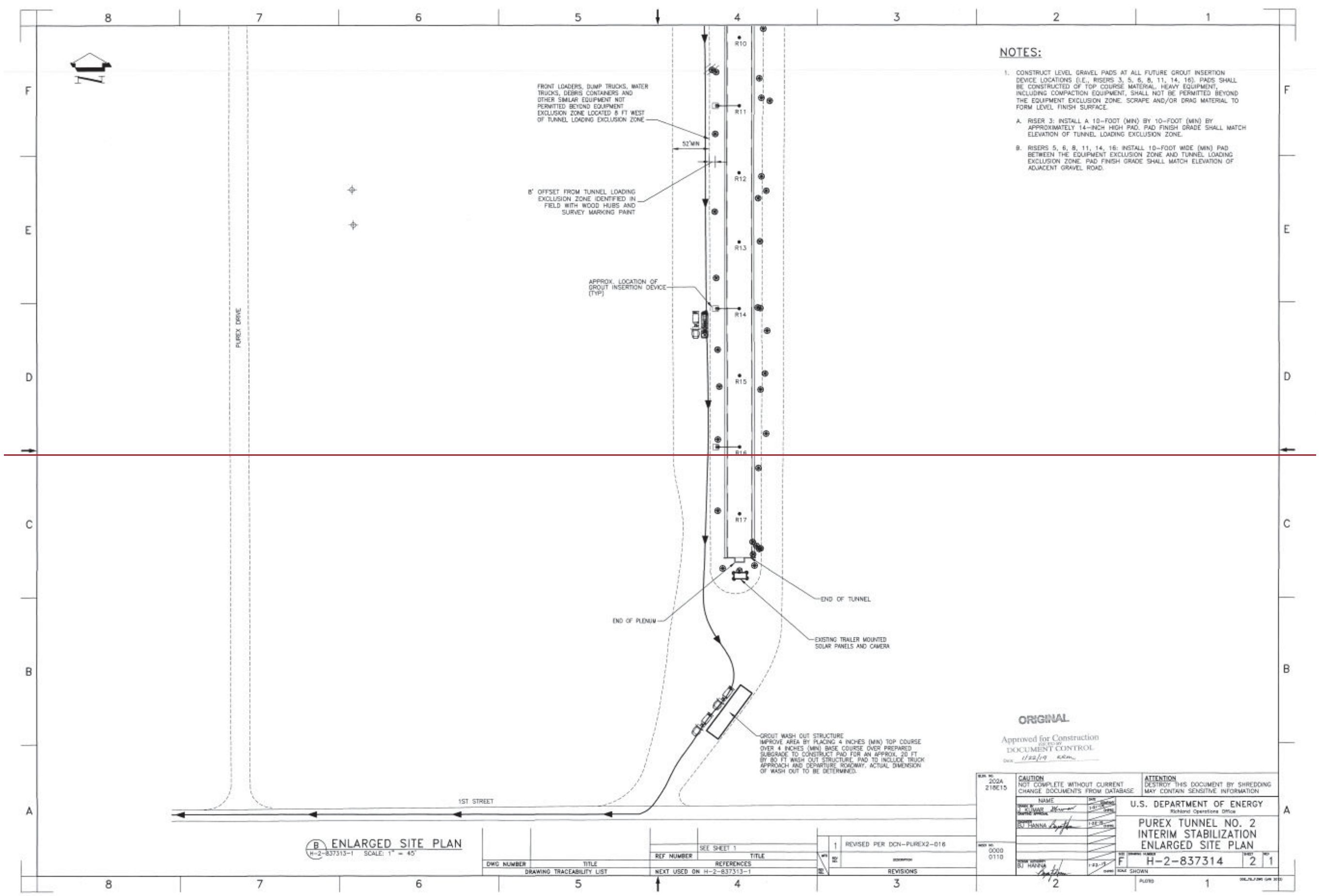

Figure 11.15. PUREX Tunnel NO. 2 Interim Stabilization Enlarged Site Plan 2, #H-2-837314-2

Commented [MPW-C4]: Replace this Figure with the updated Figure.

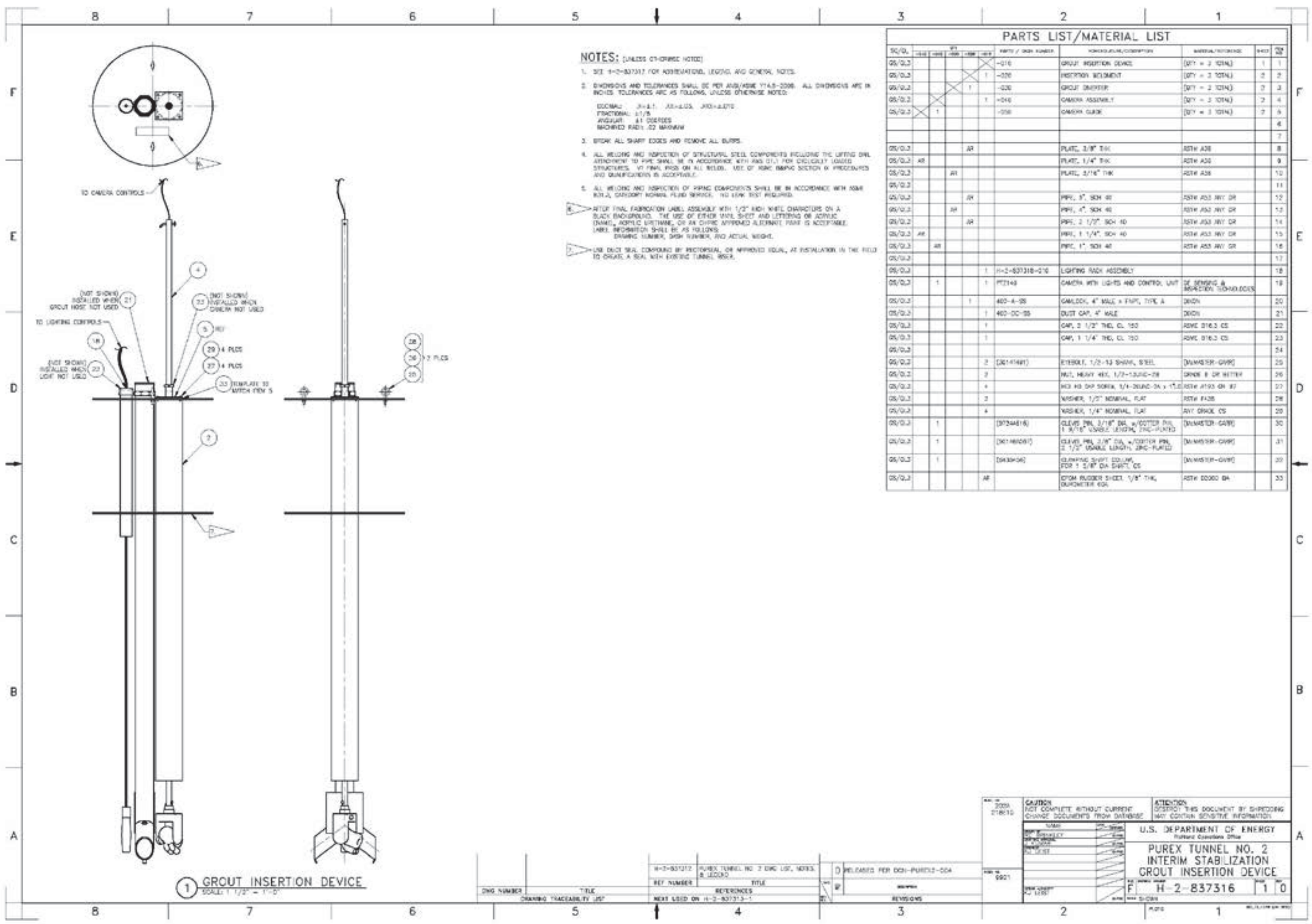

Figure 11.16. PUREX Tunnel NO. 2 Interim Stabilization Grout Insertion Device, #H-2-837316-1

Commented [MPW-C5]: Replace this Figure with the updated Figure.

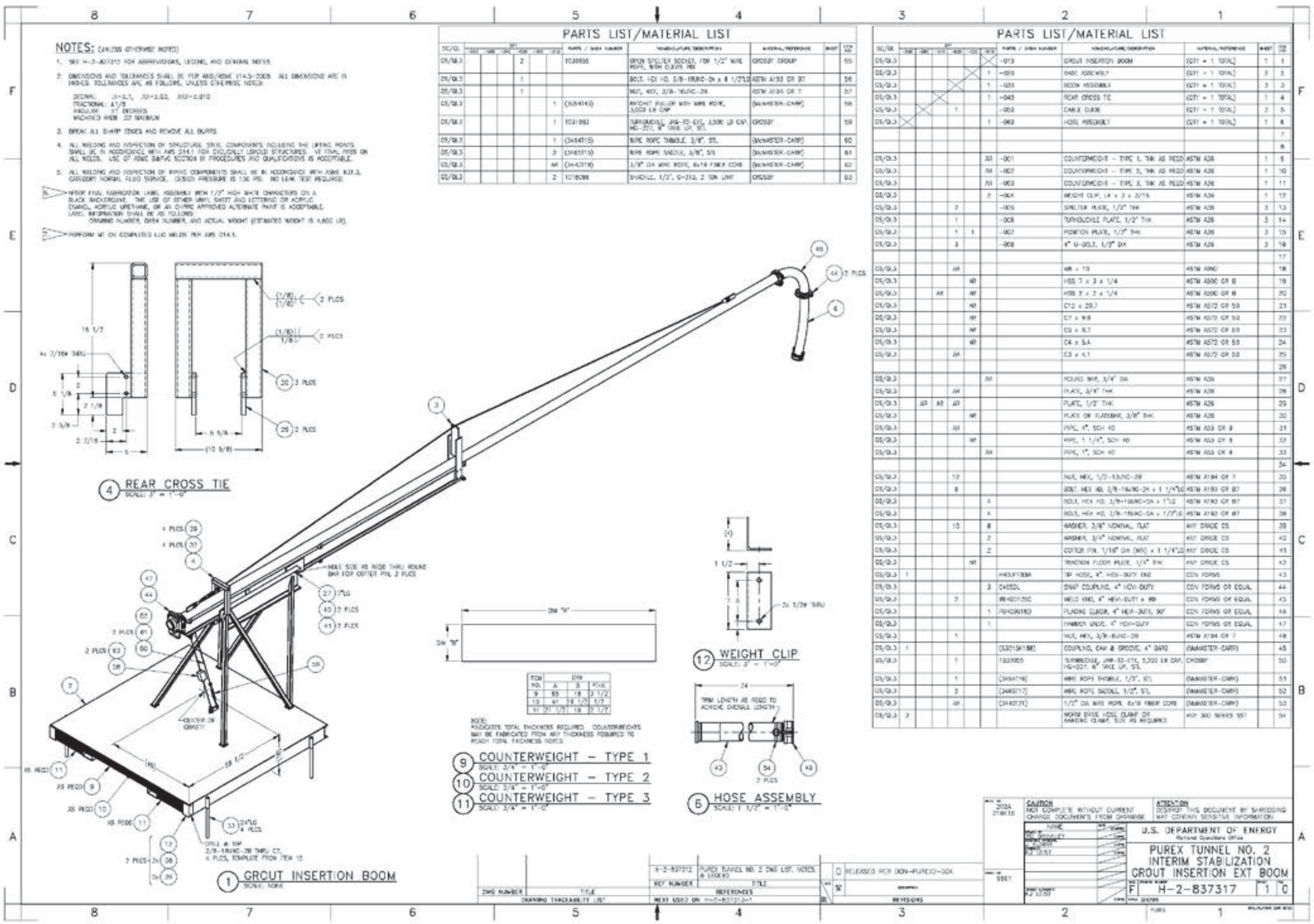

Figure 11.17. PUREX Tunnel NO. 2 Interim Stabilization Grout Insertion EXT Boom, #H-2-837317

Commented [MPW-C6]: Replace this Figure with the updated Figure.

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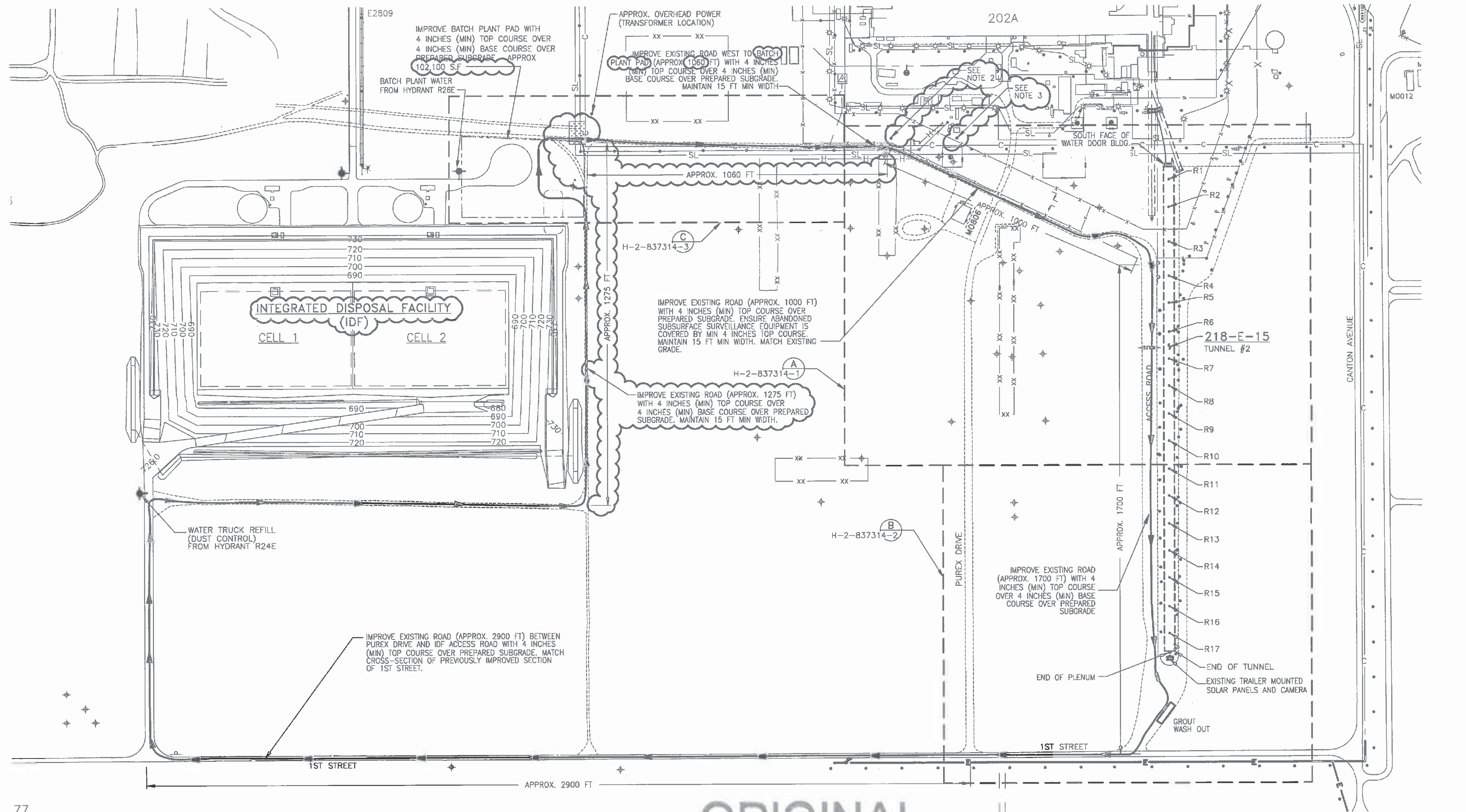

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ORIGINAL

NOTES:

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. BRASS SURVEY MARKER (N39557, W48900, EL 713.00)
3. BRASS SURVEY MARKER (N39557, W48600, EL 711.99)

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IS:

7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK RELATED TO CONSTRUCTION, ERECTION METHODS, BRACING, SHORING, RIGGING, GUYS, SCAFFOLDING, FORMWORK, ETC. REQUIRED TO SAFELY PERFORM THE WORK.

8. CONTRACTOR SHALL PROVIDE TEMPORARY BRACING AS REQUIRED TO MAINTAIN STABILITY DURING CONSTRUCTION.

9. DATUM: EL 744'-6" = TOC ROOF SLAB AT SOUTHWEST CORNER OF TUNNEL 2 NORTH WATER-FILLED DOOR CONCRETE SUPPORT STRUCTURE. CONTRACTOR SHALL ESTABLISH ELEVATION CONTROL FROM EXST GROUND MOUNTED BRASS SURVEY MARKER BASED ON DATUM ELEVATION.

DESIGN CRITERIA

1. LIVE LOAD: 25 PSF CONSTRUCTION LOAD
2. WIND LOAD (ULTIMATE): 110 MPH WIND SPEED (3-SEC GUST), EXPOSURE C
3. SOIL:
   - ALLOWABLE BEARING PRESSURE: 1500 PSF
   - LATERAL EARTH PRESSURE EQUIVALENT FLUID PRESSURE

     (AT-REST CONDITION):

     55 PSF/FT EXST TUNNEL SOIL COVER

     63 PSF/FT GRANULAR FILL

     0.5 AT-REST LATERAL EARTH PRESSURE COEFFICIENT
   - SOIL UNIT WEIGHT: 110 PCF TUNNEL COVER SOIL

     125 PCF GRANULAR FILL (AVERAGE MOIST UNIT WT)
4. STRUCTURE PERFORMANCE CATEGORY: PC-1, GENERAL SERVICE IN ACCORDANCE WITH PRC-PRO-EN-097, ENGINEERING DESIGN AND EVALUATION (NATURAL PHENOMENA HAZARD), REV 2.

EARTHWORK

1. CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE SLOPE OF ALL EXCAVATIONS WHEN REQUIRED (1.5:1 MINIMUM HORIZONTAL-TO-VERTICAL UNLESS APPROVED BY THE STRUCTURAL ENGINEER) BASED ON THE TYPE AND CONDITION OF SOIL ENCOUNTERED AND ~~FOR CONFORMING TO ALL LOCAL, STATE, AND FEDERAL REQUIREMENTS~~, INCLUDING DOE-0344, HANFORD SITE EXCAVATING, TRENCHING AND SHORING PROCEDURE.
2. AT-REST LATERAL EARTH PRESSURE COEFFICIENTS:
   - $K_o = 0.50$ HORIZONTAL GROUND SURFACE
   - $K_{oi} = K_o*[1+\sin(\theta)]$ SLOPING GROUND SURFACE

     (θ = SLOPE OF GROUND SURFACE IN DEGREES)
3. AVERAGE MOIST UNIT WEIGHT OF EXST TUNNEL COVER 110 PCF.
4. GROUNDWATER TABLE IS MORE THAN 300 FT BELOW PROJECT SITE.
5. MATERIALS:
   - BASE COURSE SHALL CONFORM TO WSDOT M41-10 SECTION 9-03.9(3).
   - TOP COURSE SHALL CONFORM TO WSDOT M41-10 SECTION 9-03.9(3) OR MAINTENANCE ROCK CONFORMING TO WSDOT M41-10 SECTION 9-03.9(4).
6. CLEAR AND GRUB ALL IMPROVEMENT AREAS SHOWN ON SITE PLAN. PLACE STRIPPINGS IN GOVERNMENT FURNISHED CONTAINERS FOR REMOVAL BY OTHERS.
7. UNIFORMLY MOISTEN OR AERATE SUBGRADE AND EACH SUBSEQUENT LAYER OF BASE COURSE AND TOP COURSE BEFORE COMPACTION TO WITHIN TWO (2) PERCENT OF OPTIMUM MOISTURE CONTENT. REMOVE AND REPLACE, OR SCARIFY AND AIR DRY, OTHERWISE SATISFACTORY SOIL MATERIAL THAT EXCEEDS OPTIMUM MOISTURE CONTENT BY MORE THAN TWO (2) PERCENT.
8. VIBRATORY EQUIPMENT SHALL NOT BE USED TO PROVIDE COMPACTION. ALL COMPACTION SHALL BE PERFORMED WITH PNEUMATIC AND SMOOTH DRUM ROLLERS (WITHOUT VIBRATION). COMPACT WITH 15-20 TON, SELF-PROPELLED, PNEUMATIC ROLLER A MINIMUM OF FOUR OVERLAPPING PASSES. ALTERNATELY, COMPACTION MAY BE PERFORMED WITH A 25-35 TON, SELF-PROPELLED, SMOOTH DRUM ROLLER WITH VIBRATORY CAPABILITY REMOVED. MAXIMUM RATE OF ROLLER TRAVEL SHALL NOT EXCEED 8 MPH. AFTER FINAL COMPACTION OF TOP COURSE, THE ENTIRE SURFACE SHALL BE ROLLED WITH A SMOOTH-WHEELED ROLLER. ROLLING SHALL CONTINUE UNTIL THE ENTIRE ROADWAY SURFACE PRESENTS A FIRM, DAMP,

ENGINEERED GROUT

1. ENGINEERED GROUT FILLING OF THE TUNNEL INTERIOR IS FOR THE PURPOSE OF STABILIZATION AND SUPPORT OF THE EXST TUNNEL STRUCTURE AND FOR STABILIZATION AND CONTAINMENT OF CONTAMINATED EQUIPMENT LOCATED WITHIN THE TUNNEL.
2. UNLESS OTHERWISE APPROVED, GROUT MIX FORMULATION SHALL INCLUDE USE OF THE FOLLOWING MATERIALS:
   - CEMENT — TYPE I-II, ASTM C150 OR TYPE IL, ASTM C595
   - FLY ASH — CLASS F, ASTM C618
   - FINE AGGREGATE — NATURAL SANDS ONLY, ASTM C33 (MFRD SAND IS NOT ALLOWED)
   - WATER-REDUCING ADMIXTURE — TYPE A OR D, ASTM C494, CONTAINING NO CHLORIDES
   - SET RETARDER — MASTERSET DELVO AS MFRD BY BASF
   - WATER — CLEAN AND POTABLE CONTAINING LESS THAN 500 PPM CHLORIDES OR NON-POTABLE WATER SUPPLIED FROM LOCAL FIRE HYDRANT
3. UNLESS OTHERWISE APPROVED, GROUT PROPERTIES SHALL INCLUDE THE FOLLOWING:
   - SELF CONSOLIDATING, CAPABLE OF HORIZONTAL PLACEMENTS UP TO 200 FEET
   - WATER/CEMENT RATIO (W/C) — 0.60 FOR GROUT MIX DESIGN
   - SPREAD — 28 INCH MIN DIAMETER UNLESS OTHERWISE APPROVED BY THE STRUCTURAL ENGINEER, ASTM C1611
   - MINIMUM COMPRESSIVE STRENGTH — 2000 PSI AT 28-DAYS
   - CAPABLE OF ENTERING AND FILLING OPENINGS AND VOIDS WITH 1/2 INCH MINIMUM DIMENSION
   - CAPABLE OF PLACEMENT FOR UP TO 3 HOURS MIN AFTER ADDING CEMENT TO WATER, DEMONSTRATED THROUGH DOCUMENTED TRIAL BATCH TESTING
4. GROUT MIX DESIGN SHALL BE DEVELOPED IN COLLABORATION WITH THE STRUCTURAL ENGINEER AND DEMONSTRATED TO MEET DESIGN AND CONSTRUCTION PROJECT REQUIREMENTS THROUGH A MINIMUM OF (2) TWO DOCUMENTED TRIAL BATCH TESTING THAT ARE WITNESSED, REVIEWED, AND APPROVED BY THE STRUCTURAL ENGINEER.
5. TRIAL BATCH TESTING SHALL BE PERFORMED AS DIRECTED BY THE STRUCTURAL ENGINEER AND SHALL INCLUDE THE FOLLOWING:
   - MINIMUM FLOW — 80 LINEAR FEET HORIZONTALLY WITHOUT SEGREGATION
   - TEMPERATURE — ASTM C1064
   - TIME OF SET — FINAL SET TIME
   - DENSITY — ASTM C642
   - COMPRESSIVE STRENGTH — ASTM C39 USING 4" DIA x 8" TEST CYLINDERS, MIN 1 PAIR CYLINDERS TESTED AT 1, 2, 3, 7 AND 28 DAYS AFTER SAMPLING
6. GROUT FIELD QUALITY CONTROL SHALL INCLUDE THE FOLLOWING:
   - PROVIDE ADEQUATE FACILITIES FOR SAFE STORAGE AND PROPER CURING OF GROUT TEST CYLINDERS ON SITE FOR FIRST 24 HOURS INCLUDING ADDITIONAL TIME AS REQUIRED BEFORE TRANSPORTING TO TEST LAB FOR CYLINDERS TO BE TESTED AT 3, 7, AND 28 DAYS.
     - A. IN THE EVENT, THE 3-DAY OR 7-DAY "BREAK" IS TO BE PERFORMED ON A "NON-WORKDAY", IT MAY OCCUR THE FOLLOWING WORK DAY.
     - B. IN THE EVENT GROUT IS PLACED ON A FRIDAY OR SATURDAY (OR EXTENDED WEEKEND), INITIAL CURE TIME MAY BE EXTENDED TO A MAXIMUM 72 HOURS.
   - PROVIDE GROUT FOR TESTING INCLUDING SLUMP FLOW, TEMPERATURE, UNIT WEIGHT AND MAKING OF GROUT TEST CYLINDERS AFTER FIELD ADDITION OF SUPERPLASTICIZERS AND WORKABILITY-RETAINING ADMIXTURES.

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WAS: NOTES:

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. ROLL CHAIN LINK FABRIC OUT OF HARMS WAY. REMOVE POST AND SAVE. SAVE ALL PARTS FOR REINSTALLATION.
3. CLEAR AREA TO INCLUDE:
   - A. REMOVE LIGHT POSTS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. UNBOLT POSTS, SIZE REDUCE TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINER FOR DISPOSAL BY OTHERS. CUT AND CAP CONDUCTORS. CUT OFF BOLTS AND CONDUIT FLUSH WITH CONCRETE, AND INSTALL CONDUIT PLUG/CAP. ENSURE TOP COURSE COVERS CONCRETE TO PROVIDE LEVEL AND SAFE DRIVING SURFACE. ABANDON-IN-PLACE CONCRETE FOOTINGS.
   - B. REMOVE SURVEILLANCE EQUIPMENT UNITS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. CUT AND CAP CONDUCTORS. CUT EQUIPMENT SUPPORTS AND CONDUIT 6 INCHES BELOW GRADE (MAX), INSTALL CONDUIT PLUG/CAP, AND ABANDON-IN-PLACE. SIZE REDUCE DEBRIS TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINERS FOR DISPOSAL BY OTHERS. ENSURE TOP COURSE COVERS ABANDONED SUPPORTS AND CONDUITS TO PROVIDE LEVEL AND SAFE DRIVING SURFACE.
4. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.
   - A. RISER 3: INSTALL A 10 FT (MIN) BY 10 FT (MIN) BY APPROXIMATELY 14 INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.
   - B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10 FT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.
5. INSTALL PTZ-70 CAMERA, THEN LIGHT. LIGHT SHALL HANG AT LEAST 12 INCHES BELOW CAMERA HEAD. USE CABLE TIES TO ATTACH CABLES TO LIFTING BAIL. RUBBER MATTING WITH SLIT WILL BE USED IN CONJUNCTION WITH TAPE TO SEAL OFF OPENING. CAMERA AND LIGHT WILL BE POSITIONED AT DIRECTION OF ENGINEERING.
6. RISER UTILIZATION SHALL BE IN ACCORDANCE WITH MEMORANDUM #CP-ENG-0004 (LATEST REVISION) DURING THE COMPLETION (I.E. TOPPING OFF) PHASE. ENGINEERING SHALL DOCUMENT INITIATION OF TOPPING OFF PHASE WITH A WORK RECORD ENTRY.

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IS: NOTES:

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. ROLL CHAIN LINK FABRIC OUT OF HARMS WAY. REMOVE POST AND SAVE. SAVE ALL PARTS FOR REINSTALLATION.
3. CLEAR AREA TO INCLUDE:
   - A. REMOVE LIGHT POSTS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. UNBOLT POSTS, SIZE REDUCE TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINER FOR DISPOSAL BY OTHERS. CUT AND CAP CONDUCTORS. CUT OFF BOLTS AND CONDUIT FLUSH WITH CONCRETE, AND INSTALL CONDUIT PLUG/CAP. ENSURE TOP COURSE COVERS CONCRETE TO PROVIDE LEVEL AND SAFE DRIVING SURFACE. ABANDON-IN-PLACE CONCRETE FOOTINGS.
   - B. REMOVE SURVEILLANCE EQUIPMENT UNITS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. CUT AND CAP CONDUCTORS. CUT EQUIPMENT SUPPORTS AND CONDUIT 6 INCHES BELOW GRADE (MAX), INSTALL CONDUIT PLUG/CAP, AND ABANDON-IN-PLACE. SIZE REDUCE DEBRIS TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINERS FOR DISPOSAL BY OTHERS. ENSURE TOP COURSE COVERS ABANDONED SUPPORTS AND CONDUITS TO PROVIDE LEVEL AND SAFE DRIVING SURFACE.
4. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.
   - A. RISER 3: INSTALL A 10 FT (MIN) BY 10 FT (MIN) BY APPROXIMATELY 14 INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.
   - B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10 FT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.
5. INSTALL PTZ-70 CAMERA, THEN LIGHT. LIGHT SHALL HANG AT LEAST 12 INCHES BELOW CAMERA HEAD. USE CABLE TIES TO ATTACH CABLES TO LIFTING BAIL. RUBBER MATTING WITH SLIT WILL BE USED IN CONJUNCTION WITH TAPE TO SEAL OFF OPENING. CAMERA AND LIGHT WILL BE POSITIONED AT DIRECTION OF ENGINEERING.
6. RISER UTILIZATION SHALL BE IN ACCORDANCE WITH MEMORANDUM #CP-ENG-0004 (LATEST REVISION) DURING THE COMPLETION (I.E. TOPPING OFF) PHASE. ENGINEERING SHALL DOCUMENT INITIATION OF TOPPING OFF PHASE WITH A WORK RECORD ENTRY.
7. REMOVE UPON COMPLETION OF GROUTING ACTIVITIES AS DIRECTED BY BTR.
8. EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE NOT APPLICABLE UPON COMPLETION OF GROUTING ACTIVITIES/TUNNEL STABILIZATION.

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WAS:

TUNNEL #2 RISERS

RISER NO.	NOTE	DISTANCE FROM SOUTH FACE OF WATER DOOR BLDG	RISER UTILIZATION DESCRIPTION (NOTE 6)
1	4	47.17'	
2	1,3	141.18'	VENTILATION/SECONDARY INSERTION DEVICE
3	1,2	264.66'	GROUT INSERTION DEVICE/VENTILATION
4	3	383.97'	SECONDARY INSERTION DEVICE
5	2	478.08'	GROUT INSERTION DEVICE
6	2	578.64'	GROUT INSERTION DEVICE
7	3	672.79'	SECONDARY INSERTION DEVICE
8	2	767.37'	GROUT INSERTION DEVICE
9	3	864.71'	SECONDARY INSERTION DEVICE
10	3	959.18'	SECONDARY INSERTION DEVICE
11	2	1056.74'	GROUT INSERTION DEVICE
12	3	1151.12'	SECONDARY INSERTION DEVICE
13	3	1248.60'	SECONDARY INSERTION DEVICE
14	2	1342.64'	GROUT INSERTION DEVICE
15	3	1436.97'	SECONDARY INSERTION DEVICE
16	2	1537.64'	GROUT INSERTION DEVICE
17	3	1631.87'	SECONDARY INSERTION DEVICE

1. DETAIL 15, H-2-837310, SHT 2
2. DETAIL 1, H-2-837316, SHT 1
3. DETAIL 6, H-2-837316, SHT 2
4. NOTE 5, H-2-837314, SHT 1

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TUNNEL #2 RISERS

RISER NO.	NOTE	DISTANCE FROM SOUTH FACE OF WATER DOOR BLDG	RISER UTILIZATION DESCRIPTION (NOTE 6)
1	4,5	47.17'	3-INCH GROUTING ADAPTER
2	1,3	141.18'	VENTILATION/SECONDARY INSERTION DEVICE
3	1,2	264.66'	GROUT INSERTION DEVICE/VENTILATION
4	3	383.97'	SECONDARY INSERTION DEVICE
5	2	478.08'	GROUT INSERTION DEVICE
6	2	578.64'	GROUT INSERTION DEVICE
7	3	672.79'	SECONDARY INSERTION DEVICE
8	2	767.37'	GROUT INSERTION DEVICE
9	3	864.71'	SECONDARY INSERTION DEVICE
10	3	959.18'	SECONDARY INSERTION DEVICE
11	2	1056.74'	GROUT INSERTION DEVICE
12	3	1151.12'	SECONDARY INSERTION DEVICE
13	3	1248.60'	SECONDARY INSERTION DEVICE
14	2	1342.64'	GROUT INSERTION DEVICE
15	3	1436.97'	SECONDARY INSERTION DEVICE
16	2	1537.64'	GROUT INSERTION DEVICE
17	3	1631.87'	SECONDARY INSERTION DEVICE

1. DETAIL 15, H-2-837310, SHT 2
2. DETAIL 1, H-2-837316, SHT 1
3. DETAIL 6, H-2-837316, SHT 2
4. ~~NOTE 5, H-2-837314, SHT 1~~
5. DETAIL 1, H-2-837319, SHT 1 (UPON COMPLETION OF GROUTING ACTIVITIES, REMOVE ADAPTER, CUT OR DRIVE WEDGE ANCHORS FLUSH WITH CONCRETE, AND REINSTALL STEEL PLUG.)

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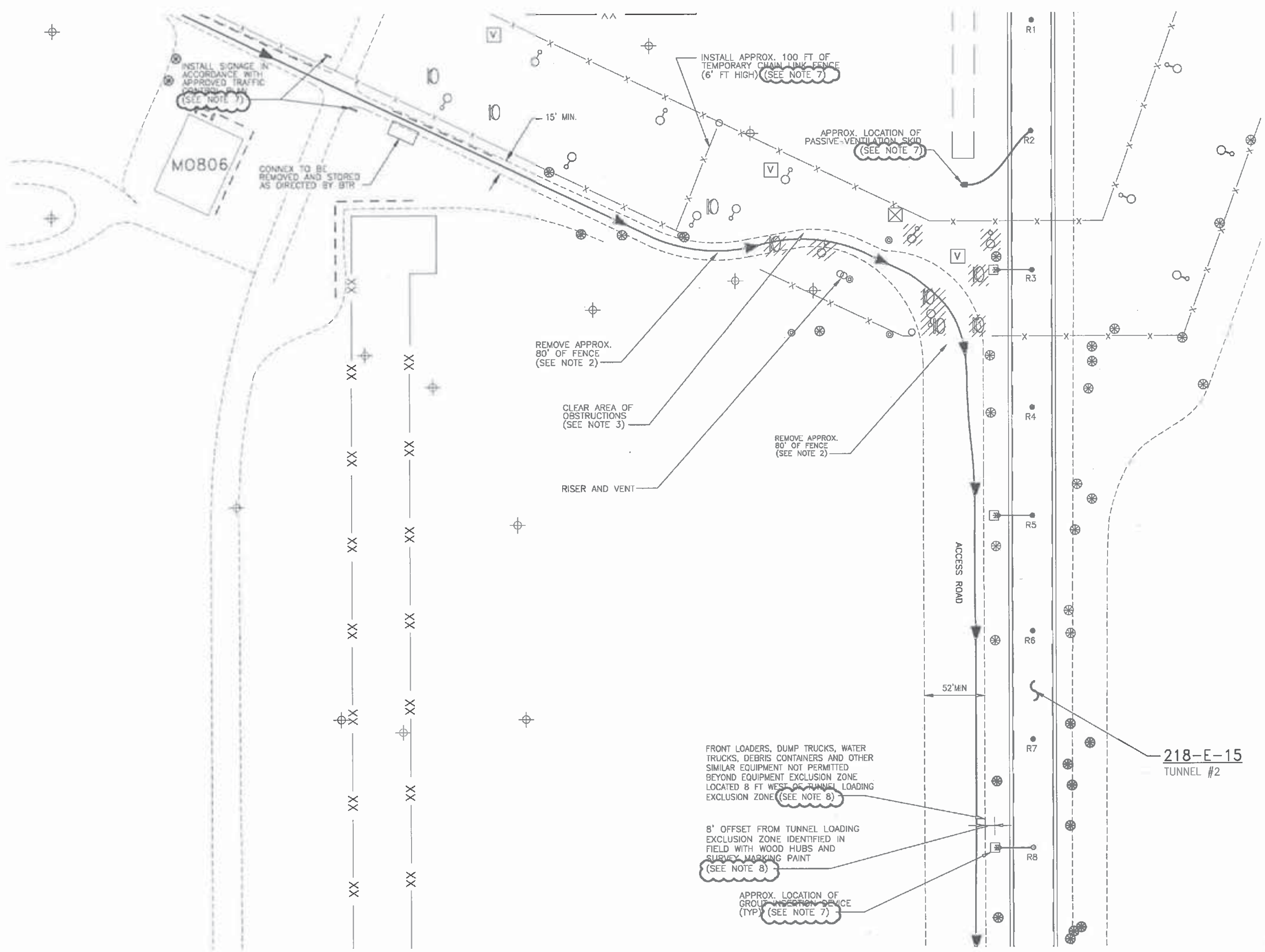

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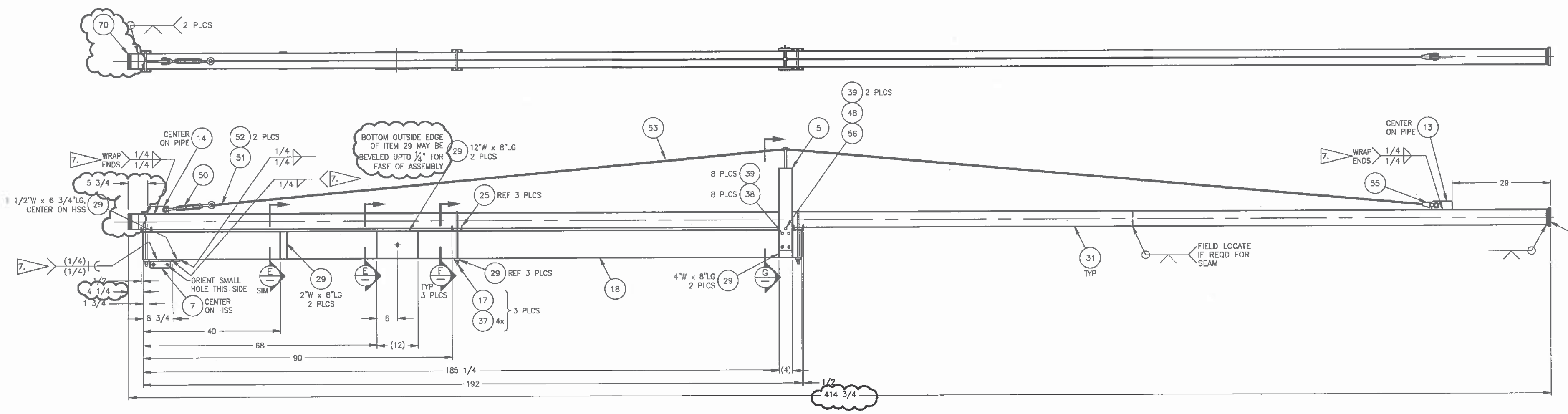
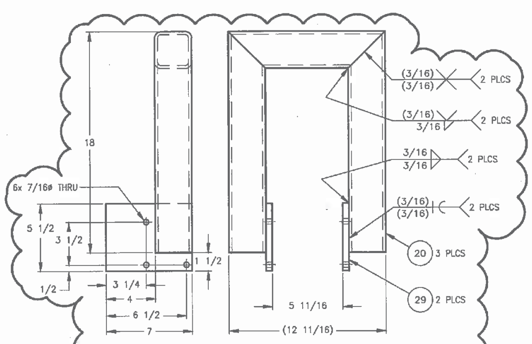
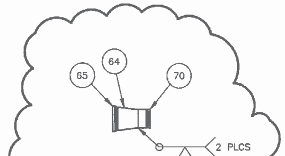


3 BOOM ASSEMBLY
SCALE: 1" = 1'-0"

DRAFTING NOTE:
MOVED FROM SHEET 1,
NO CHANGE



4 REAR CROSS TIE
SCALE: 3" = 1'-0"



8 ADAPTER
SCALE: 3" = 1'-0"

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WAS:

NOTES:

1. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.

   A. RISER 3: INSTALL A 10–FOOT (MIN) BY 10–FOOT (MIN) BY APPROXIMATELY 14–INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.

   B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10–FOOT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.

IS:

NOTES:

1. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.

   A. RISER 3: INSTALL A 10–FOOT (MIN) BY 10–FOOT (MIN) BY APPROXIMATELY 14–INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.

   B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10–FOOT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.

2. EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE NOT APPLICABLE UPON COMPLETION OF GROUTING ACTIVITIES/TUNNEL STABILIZATION.

3. REMOVE UPON COMPLETION OF GROUTING ACTIVITIES AS DIRECTED BY BTR.

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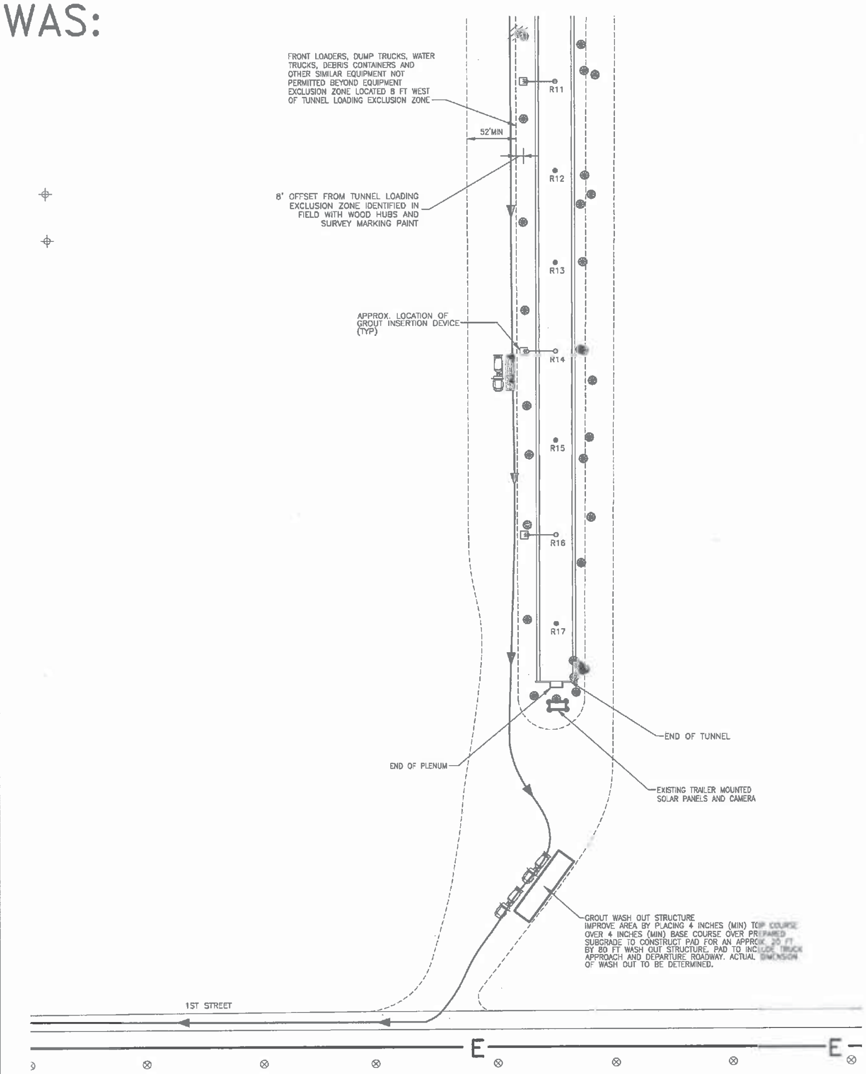
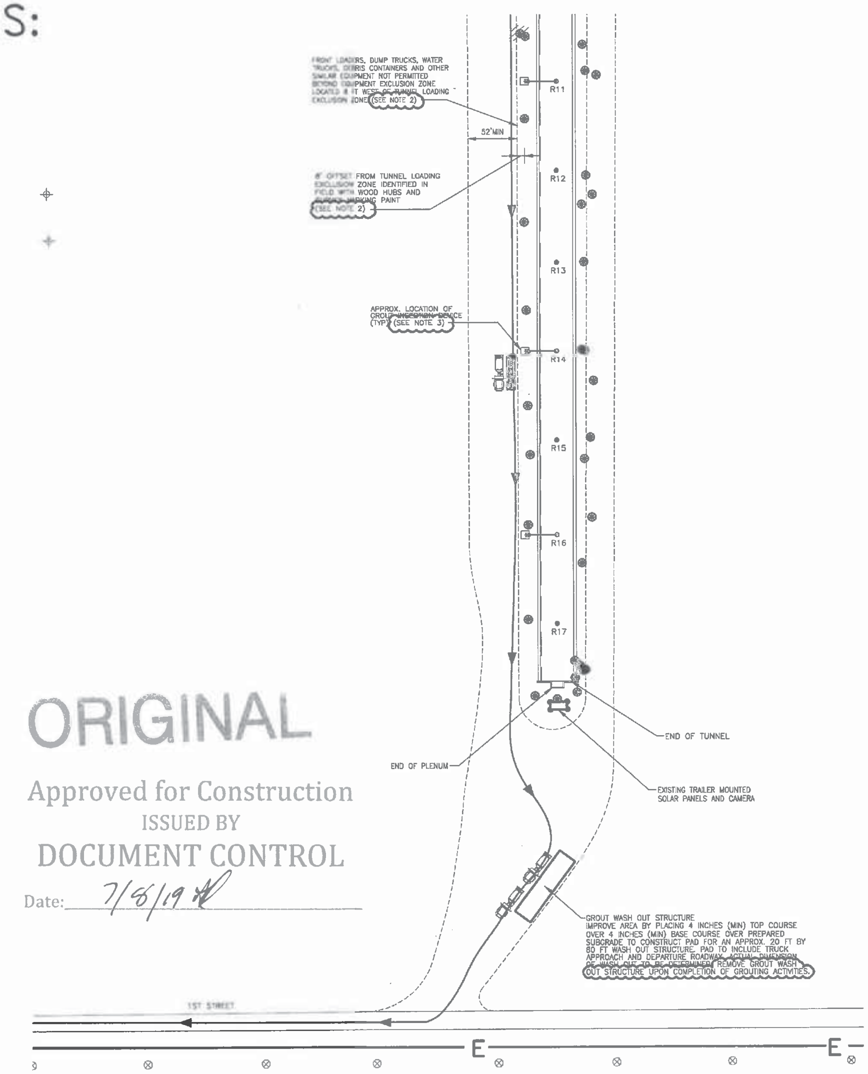
WAS:



IS:



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CHPRC			DESIGN CHANGE NOTICE	
BASE DOC. NO. H-2-837314	SH/PG 2	REV. 1	DCN- PUREX2-019	PAGE 13 of 27

WAS:

PARTS LIST/MATERIAL LIST

SC/QL	QTY -060	QTY -050	QTY -040	QTY -030	QTY -020	QTY -010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3							-010	GROUT INSERTION DEVICE	(QTY = 3 TOTAL)	1	
GS/QL3						1	-020	INSERTION WELDMENT	(QTY = 3 TOTAL)	2	
GS/QL3					1		-030	GROUT DIVERTER	(QTY = 3 TOTAL)	2	
GS/QL3						1	-040	CAMERA ASSEMBLY	(QTY = 3 TOTAL)	2	
GS/QL3			1				-050	CAMERA GUIDE	(QTY = 3 TOTAL)	2	
GS/QL3							-060	SECONDARY INSERTION DEVICE	(QTY = 1 TOTAL)	2	
GS/QL3	AR				AR			PLATE, 3/8" THK MIN	ASTM A36		
GS/QL3		AR						PLATE, 1/4" THK	ASTM A36		
GS/QL3		AR		AR				PLATE, 3/16" THK	ASTM A36		
GS/QL3			AR					PLATE, 1/4" THK	ASTM A240 TYPE 316		
GS/QL3					AR			PIPE, 6", SCH 40	ASTM A53 ANY GR		
GS/QL3				AR				PIPE, 4", SCH 40	ASTM A53 ANY GR		
GS/QL3					AR			PIPE, 2 1/2", SCH 40	ASTM A53 ANY GR		
GS/QL3		AR						PIPE, 1 1/2", SCH 40	ASTM A53 ANY GR		
GS/QL3			AR					TUBE, 1 1/2" OD X 16 GA WALL	ANY 300 GR SST		
GS/QL3						1	H-2-837318-010	LIGHTING RACK ASSEMBLY			
GS/QL3			1			1	PTZ140	CAMERA WITH LIGHTS AND CONTROL UNIT	GE SENSING & INSPECTION TECHNOLOGIES		
GS/QL3					1		400-A-SS	CAMLOCK, 4" MALE x FNPT, TYPE A	DIXON		
GS/QL3						1	400-DC-SS	DUST CAP, 4" MALE	DIXON		
GS/QL3						1		CAP, 2 1/2" THD, CL 150	ASME B16.3 CS		
GS/QL3						1		CAP, 1 1/2" THD, CL 150	ASME B16.3 CS		
GS/QL3	2					2	46602	EYEBOLT, SWIVEL, 2500# WLL	ACTEK		
GS/QL3	2					2		NUT, HEAVY HEX, 1/2-13UNC-2B	ASTM A563 GR B		
GS/QL3						4		HHCS, 1/4-20UNC-2A x 1" LG	ASTM A193 GR B7		
GS/QL3	2					2		WASHER, 1/2" NOMINAL, FLAT	ASTM F436		
GS/QL3						4		WASHER, 1/4" NOMINAL, FLAT	ANY GRADE CS		
GS/QL3			4					HHCS, 1/4-20UNC-2A x 1/2" LG	ASTM A193 GR B7		
GS/QL3			1				(90146A067)	CLEVIS PIN, 3/8" DIA, w/COTTER PIN, 2 1/2" USABLE LENGTH, ZINC-PLATED	(McMASTER-CARR)		
GS/QL3			1				(6435K23)	CLAMPING SHAFT COLLAR, FOR 1 1/2" DIA SHAFT, CS	(McMASTER-CARR)		
GS/QL3						AR		EPDM RUBBER SHEET, 1/8" THK, DUROMETER 60A	ASTM D2000 BA		
GS/QL3	1						WE50D125C	WELD END, 5", HEVI-DUTY x BW	CON FORMS OR EQUAL		
GS/QL3	1						C50SDL	SNAP COUPLING, 5" HEVI-DUTY	CON FORMS OR EQUAL		
GS/QL3	1							HAMMER VALVE, 5" HEVI-DUTY	CON FORMS OR EQUAL		
GS/QL3	AR							PIPE, 5", SCH 40	ASTM A53 ANY GR		
GS/QL3	AR							PIPE, 3", SCH 40	ASTM A53 ANY GR		
GS/QL3	1							REDUCER, 5"x4", ECC, BW, SCH 40	ASME B16.9, ASTM A234 CS		
GS/QL3	1							ELBOW, 5", LR, BW, SCH 40	ASME B16.9, ASTM A234 CS		
GS/QL3	1							CAP, 3" THD, CL 150	ASME B16.3 CS		
GS/QL3	AR							TUBING, 3/16" ID	TYGON OR EQUAL		
GS/QL3	2							FLANGE, 5", SO, RF, CL 150	ASTM A105		
GS/QL3	1							BLIND FLANGE, 5", RF, CL 150	ASTM A105		
GS/QL3	1							GASKET, 5", 1/8" THK, FF, CL 150	ASTM D2000 EPDM		
GS/QL3	8							STUD, 3/4-10UNC-2A x 3 3/4" LG	ASTM A193 GR B7		
GS/QL3	16							NUT, HEAVY HEX, 3/4-10UNC-2B	ASTM A194 GR 7		

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PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	QTY -070	QTY -060	QTY -050	QTY -040	QTY -030	QTY -020	QTY -010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3									-010	GROUT INSERTION DEVICE	(QTY = 3 TOTAL)	1	1
GS/QL3								1	-020	INSERTION WELDMENT	(QTY = 3 TOTAL)	2	2
GS/QL3							1		-030	GROUT DIVERTER	(QTY = 3 TOTAL)	2	3
GS/QL3								1	-040	CAMERA ASSEMBLY	(QTY = 3 TOTAL)	2	4
GS/QL3					1				-050	CAMERA GUIDE	(QTY = 3 TOTAL)	2	5
GS/QL3									-060	SECONDARY INSERTION DEVICE	(QTY = 1 TOTAL)	2	6
GS/QL3									-070	CAMERA PORT GROUTING ASSEMBLY		2	7
GS/QL3			AR				AR			PLATE, 3/8" THK MIN	ASTM A36		8
GS/QL3				AR						PLATE, 1/4" THK	ASTM A36		9
GS/QL3				AR		AR				PLATE, 3/16" THK	ASTM A36		10
GS/QL3					AR					PLATE, 1/4" THK	ASTM A240 TYPE 316		11
GS/QL3							AR			PIPE, 6", SCH 40	ASTM A53 ANY GR		12
GS/QL3						AR				PIPE, 4", SCH 40	ASTM A53 ANY GR		13
GS/QL3							AR			PIPE, 2 1/2", SCH 40	ASTM A53 ANY GR		14
GS/QL3				AR						PIPE, 1 1/2", SCH 40	ASTM A53 ANY GR		15
GS/QL3					AR					TUBE, 1 1/2" OD X 16 GA WALL	ANY 300 GR SST		16
GS/QL3									-080	RISER 2, 3" GROUTING ADAPTER		2	17
GS/QL3								1	H-2-837318-010	LIGHTING RACK ASSEMBLY			18
GS/QL3					1			1	PTZ140	CAMERA WITH LIGHTS AND CONTROL UNIT	GE SENSING & INSPECTION TECHNOLOGIES		19
GS/QL3							1		400-A-SS	CAMLOCK, 4" MALE x FNPT, TYPE A	DIXON		20
GS/QL3								AR	400-DC-SS	DUST CAP, 4" MALE	DIXON		21
GS/QL3								1		CAP, 2 1/2" THD, CL 150	ASME B16.3 CS		22
GS/QL3								1		CAP, 1 1/2" THD, CL 150	ASME B16.3 CS		23
GS/QL3	1									REDUCER, 5" x 3", CC, BW, SCH 40	ASME B16.9, ASTM A234 CS		24
GS/QL3			2					2	46602	EYEBOLT, SWIVEL, 2500# WLL	ACTEK		25
GS/QL3			2					2		NUT, HEAVY HEX, 1/2-13UNC-2B	ASTM A563 GR B		26
GS/QL3								4		HHCS, 1/4-20UNC-2A x 1" LG	ASTM A193 GR B7		27
GS/QL3			2					2		WASHER, 1/2" NOMINAL, FLAT	ASTM F436		28
GS/QL3								4		WASHER, 1/4" NOMINAL, FLAT	ANY GRADE CS		29
GS/QL3					4					HHCS, 1/4-20UNC-2A x 1/2" LG	ASTM A193 GR B7		30
GS/QL3					1				(90146A067)	CLEVIS PIN, 3/8" DIA, w/COTTER PIN, 2 1/2" USABLE LENGTH, ZINC-PLATED	(McMASTER-CARR)		31
GS/QL3					1				(6435K23)	CLAMPING SHAFT COLLAR, FOR 1 1/2" DIA SHAFT, CS	(McMASTER-CARR)		32
GS/QL3								AR		EPDM RUBBER SHEET, 1/8" THK, DUROMETER 60A	ASTM D2000 BA		33
GS/QL3	1		1						WE50D125C	WELD END, 5", HEVI-DUTY x BW	CON FORMS OR EQUAL		34
GS/QL3	1		1						C50SDL	SNAP COUPLING, 5" HEVI-DUTY	CON FORMS OR EQUAL		35
GS/QL3	1		1							HAMMER VALVE, 5" HEVI-DUTY	CON FORMS OR EQUAL		36
GS/QL3			AR							PIPE, 5", SCH 40	ASTM A53 ANY GR		37
GS/QL3			AR							PIPE, 3", SCH 40	ASTM A53 ANY GR		38
GS/QL3			1							REDUCER, 5" x 3", ECC, BW, SCH 40	ASME B16.9, ASTM A234 CS		39
GS/QL3			1							ELBOW, 5", LR, BW, SCH 40	ASME B16.9, ASTM A234 CS		40
GS/QL3			1							CAP, 3" THD, CL 150	ASME B16.3 CS		41
GS/QL3			AR							TUBING, 3/16" ID	TYGON OR EQUAL		42
GS/QL3			2							FLANGE, 5", SO, RF, CL 150	ASTM A105		43
GS/QL3			1							BLIND FLANGE, 5", RF, CL 150	ASTM A105		44
GS/QL3			1							GASKET, 5", 1/8" THK, FF, CL 150	ASTM D2000 EPDM		45
GS/QL3			8							STUD, 3/4-10UNC-2A x 3 3/4" LG	ASTM A193 GR B7		46
GS/QL3			16							NUT, HEAVY HEX, 3/4-10UNC-2B	ASTM A194 GR 7		47
GS/QL3		1							(53015K68)	CONNECTOR, 4" CAM-LOCK X 4" BARB STAINLESS STEEL	(McMASTER-CARR)		48
GS/QL3		AR								PLATE, 1/4" THICK	ASTM A240 TYPE 304		49
GS/QL3	1									3M COUPLING, 3" THD, CS	ANY GRADE CS		50
GS/QL3	1									PIPE, TOE, 3" x 6" LG, SCH 80	ASTM A106 ANY GR		51

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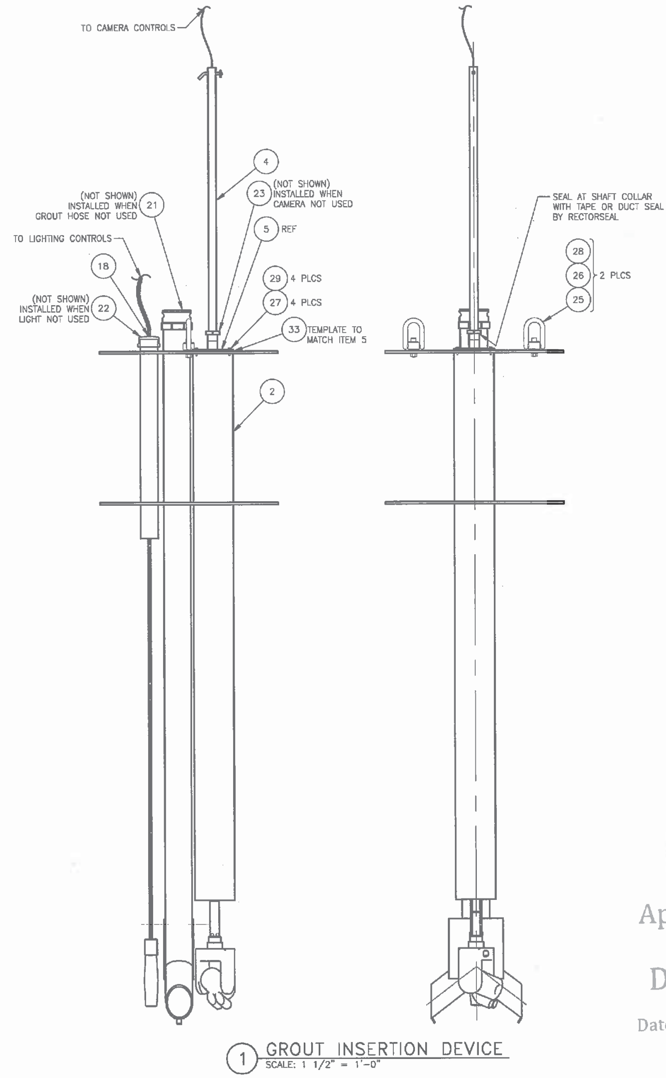
WAS:



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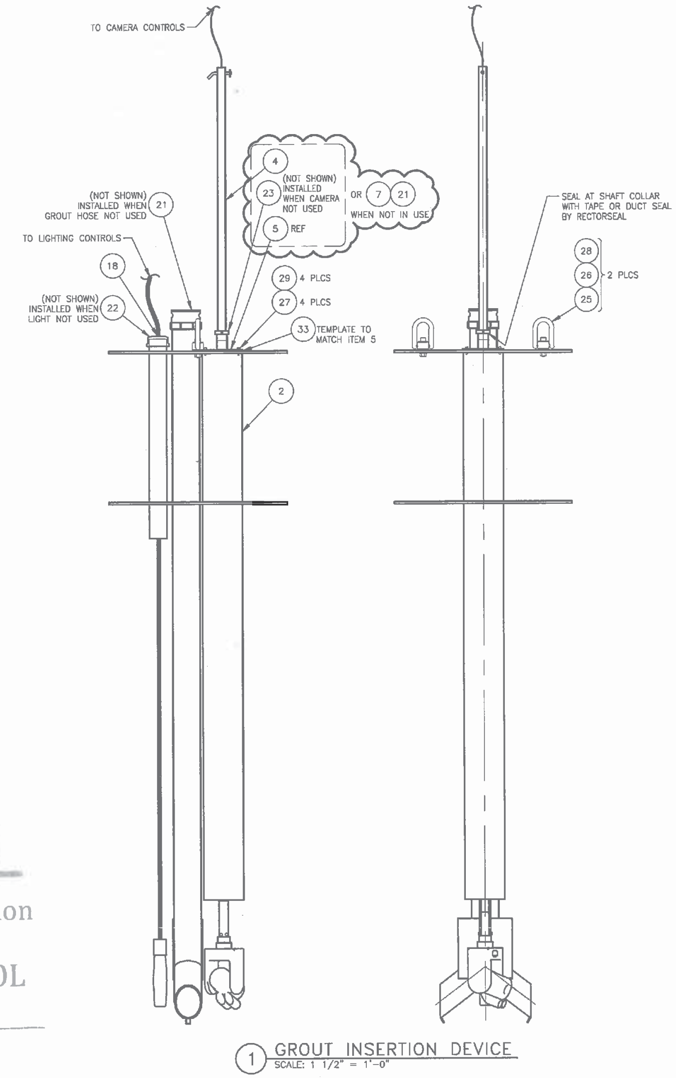

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WAS:

PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	-070	-060	-050	-040	-030	-020	-010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3								X	-010	GROUT INSERTION BOOM	(QTY = 1 TOTAL)	1	1
GS/QL3							X	1	-020	BASE ASSEMBLY	(QTY = 1 TOTAL)	2	2
GS/QL3						X		1	-030	BOOM ASSEMBLY	(QTY = 1 TOTAL)	3	3
GS/QL3					X		1		-040	REAR CROSS TIE	(QTY = 1 TOTAL)	1	4
GS/QL3				X		1			-050	CABLE GUIDE	(QTY = 1 TOTAL)	3	5
GS/QL3			X					1	-060	HOSE ASSEMBLY	(QTY = 1 TOTAL)	1	6
GS/QL3		X				1	1		-070	HOIST PLATE		3	7
GS/QL3	X							1	-080	ADAPTOR		3	8
GS/QL3								AR	-001	COUNTERWEIGHT – TYPE 1, THK AS REQD	ASTM A36	1	9
GS/QL3								AR	-002	COUNTERWEIGHT – TYPE 2, THK AS REQD	ASTM A36	1	10
GS/QL3								AR	-003	COUNTERWEIGHT – TYPE 3, THK AS REQD	ASTM A36	1	11
GS/QL3								2	-004	WEIGHT CLIP, 3/16" THK	ASTM A36	1	12
GS/QL3						1			-005	SPELTER PLATE, 1/2" THK	ASTM A36	3	13
GS/QL3						1			-006	TURNBUCKLE PLATE, 1/2" THK	ASTM A36	3	14
													15
													16
GS/QL3						3			-009	4" U-BOLT, 1/2" DIA	ASTM A36	3	17
GS/QL3						AR				HSS 8 x 4 x 1/4	ASTM A500 GR B		18
GS/QL3							AR			HSS 7 x 3 x 1/4	ASTM A500 GR B		19
GS/QL3					AR		AR			HSS 3 x 3 x 1/4	ASTM A500 GR B		20
GS/QL3							AR			C12 x 20.7	ASTM A572 GR 50		21
GS/QL3							AR			C7 x 9.8	ASTM A572 GR 50		22
GS/QL3							AR			C4 x 7.25	ASTM A572 GR 50		23
GS/QL3							AR			C4 x 5.4	ASTM A572 GR 50		24
GS/QL3						AR				C3 x 4.1	ASTM A572 GR 50		25
													26
GS/QL3								AR		ROUND BAR, 3/4" DIA	ASTM A36		27
GS/QL3		AR								PLATE, 3/4" THK	ASTM A36		28
GS/QL3		AR		AR	AR	AR		AR		PLATE, 1/2" THK	ASTM A36		29
GS/QL3							AR			PLATE OR FLATBAR, 3/8" THK	ASTM A36		30
GS/QL3						AR				PIPE, 4", SCH 40, SMLS	ASTM A53 GR B TYPE S		31
GS/QL3							AR			PIPE, 1 1/4", SCH 40	ASTM A53 GR B		32
GS/QL3								AR		PIPE, 1", SCH 40	ASTM A53 GR B		33
GS/QL3				AR						PIPE, 1/2", SCH 40	ASTM A53 GR B		34
GS/QL3						6				BOLT, HEX HD, 3/8-16UNC-2A x 7/8"LG	ASTM A193 GR B7		35
GS/QL3								4		BOLT, HEX HD, 3/8-16UNC-2A x 5/8"LG	ASTM A193 GR B7		36
GS/QL3						12				NUT, HEX, 1/2-13UNC-2B	ASTM A194 GR 2H		37
GS/QL3						8				BOLT, HEX HD, 3/8-16UNC-2A x 1"LG	ASTM A193 GR B7		38
GS/QL3						16		4		WASHER, 3/8" NOMINAL, FLAT	ANY GRADE CS		39
GS/QL3								2		WASHER, 3/4" NOMINAL, FLAT	ANY GRADE CS		40
GS/QL3								2		COTTER PIN, 1/16" DIA (MIN) x 1 1/4"LG	ANY GRADE CS		41
GS/QL3							AR			TRACTION FLOOR PLATE, 1/4" THK	ANY GRADE CS		42
GS/QL3			1						H40LF10DIA	TIP HOSE, 4", HEVI-DUTY END	CON FORMS		43
GS/QL3								2	C40SDL	SNAP COUPLING, 4" HEVI-DUTY	CON FORMS OR EQUAL		44

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PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	-070	-060	-050	-040	-030	-020	-010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3								X	-010	GROUT INSERTION BOOM	(QTY = 1 TOTAL)	1	1
GS/QL3							X	1	-020	BASE ASSEMBLY	(QTY = 1 TOTAL)	2	2
GS/QL3						X		1	-030	BOOM ASSEMBLY	(QTY = 1 TOTAL)	3	3
GS/QL3					X		1		-040	REAR CROSS TIE	(QTY = 1 TOTAL)	3	4
GS/QL3				X		1			-050	CABLE GUIDE	(QTY = 1 TOTAL)	3	5
GS/QL3			X					1	-060	HOSE ASSEMBLY	(QTY = 1 TOTAL)	1	6
GS/QL3		X				1	1		-070	HOIST PLATE		3	7
GS/QL3	X							1	-080	ADAPTOR		3	8
GS/QL3								AR	-001	COUNTERWEIGHT – TYPE 1, THK AS REQD	ASTM A36	1	9
GS/QL3								AR	-002	COUNTERWEIGHT – TYPE 2, THK AS REQD	ASTM A36	1	10
GS/QL3								AR	-003	COUNTERWEIGHT – TYPE 3, THK AS REQD	ASTM A36	1	11
GS/QL3								2	-004	WEIGHT CLIP, 3/16" THK	ASTM A36	1	12
GS/QL3						1			-005	SPELTER PLATE, 1/2" THK	ASTM A36	3	13
GS/QL3						1			-006	TURNBUCKLE PLATE, 1/2" THK	ASTM A36	3	14
													15
													16
GS/QL3						3			-009	4" U-BOLT, 1/2" DIA	ASTM A36	3	17
GS/QL3						AR				HSS 8 x 4 x 1/4	ASTM A500 GR B		18
GS/QL3							AR			HSS 7 x 3 x 1/4	ASTM A500 GR B		19
GS/QL3					AR		AR			HSS 3 x 3 x 1/4	ASTM A500 GR B		20
GS/QL3							AR			C12 x 20.7	ASTM A572 GR 50		21
GS/QL3							AR			C7 x 9.8	ASTM A572 GR 50		22
GS/QL3							AR			C4 x 7.25	ASTM A572 GR 50		23
GS/QL3							AR			C4 x 5.4	ASTM A572 GR 50		24
GS/QL3						AR				C3 x 4.1	ASTM A572 GR 50		25
													26
GS/QL3								AR		ROUND BAR, 3/4" DIA	ASTM A36		27
GS/QL3		AR								PLATE, 3/4" THK	ASTM A36		28
GS/QL3		AR		AR	AR	AR		AR		PLATE, 1/2" THK	ASTM A36		29
GS/QL3							AR			PLATE OR FLATBAR, 3/8" THK	ASTM A36		30
GS/QL3						AR				PIPE, 4", SCH 40, SMLS	ASTM A53 GR B TYPE S		31
GS/QL3							AR			PIPE, 1 1/4", SCH 40	ASTM A53 GR B		32
GS/QL3								AR		PIPE, 1", SCH 40	ASTM A53 GR B		33
GS/QL3				AR						PIPE, 1/2", SCH 40	ASTM A53 GR B		34
GS/QL3						6				BOLT, HEX HD, 3/8-16UNC-2A x 7/8"LG	ASTM A193 GR B7		35
GS/QL3								4		BOLT, HEX HD, 3/8-16UNC-2A x 5/8"LG	ASTM A193 GR B7		36
GS/QL3						12				NUT, HEX, 1/2-13UNC-2B	ASTM A194 GR 2H		37
GS/QL3						8				BOLT, HEX HD, 3/8-16UNC-2A x 1"LG	ASTM A193 GR B7		38
GS/QL3						16		4		WASHER, 3/8" NOMINAL, FLAT	ANY GRADE CS		39
GS/QL3								2		WASHER, 3/4" NOMINAL, FLAT	ANY GRADE CS		40
GS/QL3								2		COTTER PIN, 1/16" DIA (MIN) x 1 1/4"LG	ANY GRADE CS		41
GS/QL3							AR			TRACTION FLOOR PLATE, 1/4" THK	ANY GRADE CS		42
GS/QL3			1						(H40LF10DIA)	TIP HOSE, 4", HEVI-DUTY END, 150 PSI WP MIN	CON FORMS OR EQUAL		43
GS/QL3								2	C40SDL	SNAP COUPLING, 4" HEVI-DUTY	CON FORMS OR EQUAL		44

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ADD:

11. PERFORM ULTRASONIC TESTING (UT) OF THREE BOOM ASSEMBLIES IN ACCORDANCE WITH ASTM E213. PERFORM TESTING AFTER BOOM ASSEMBLY HAS CONVEYED 2000 CUBIC YARDS AND PRIOR TO CONVEYING 4000 CUBIC YARDS.

    TESTING FREQUENCY:

    a) OBTAIN WALL THICKNESS OF 4-INCH DIAMETER SCHEDULE 40 PIPE (PART NO. 31) AT FOUR LOCATIONS ALONG EACH TESTED ASSEMBLY.
    b) OBTAIN WALL THICKNESS OF 4-INCH HEVI-DUTY 90° ELBOW (PART NO. 46) AT ONE LOCATION ALONG EACH TESTED ASSEMBLY.

    SUBMITTALS:

    a) TESTING AGENCY QUALIFICATIONS.
    b) PERSONNEL TESTING QUALIFICATIONS-INSPECTOR SHALL BE AN ASNT (AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING) NDT LEVEL II TECHNICIAN.
    c) TESTING AND INSPECTION RESULTS-REPORT TO IDENTIFY WHICH BOOM ASSEMBLY WAS TESTED, LOCATION OF TEST, AND PIPE WALL THICKNESS.

DRAFTING NOTE:

MOVE REAR CROSS TIE (ITEM 4) TO SHEET 3.

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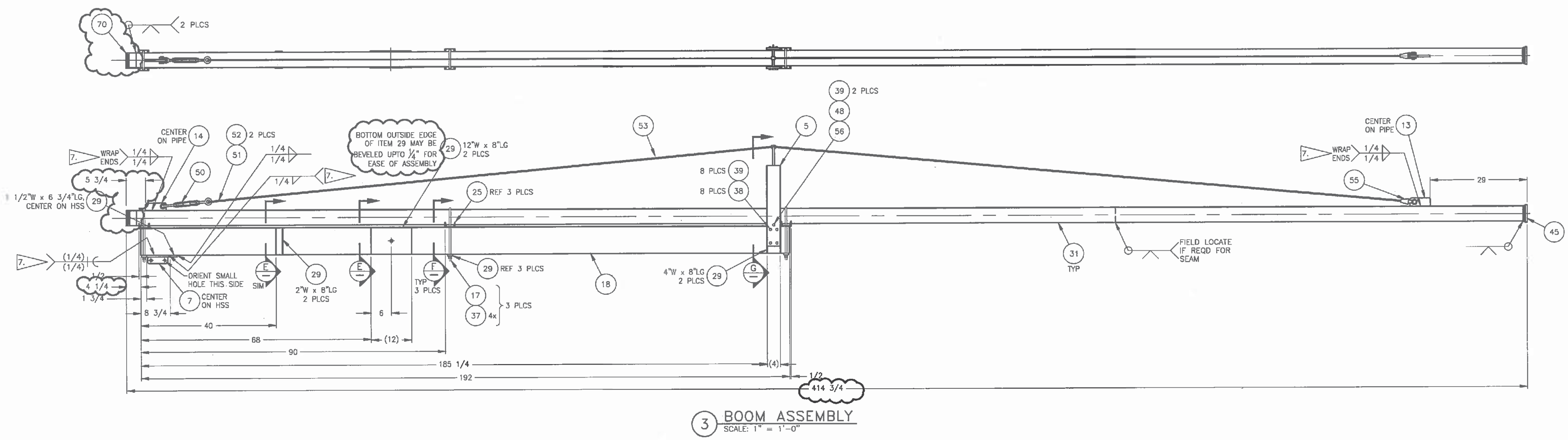
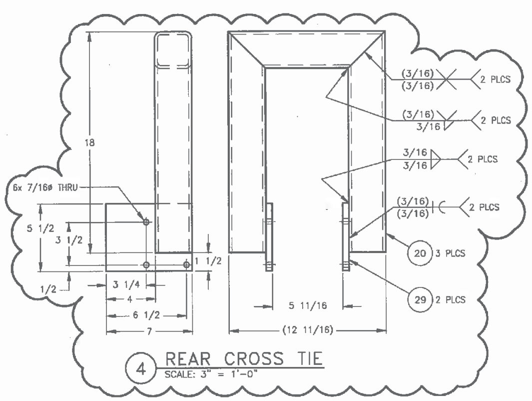
IS:



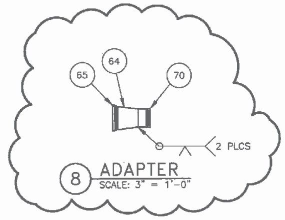
3 BOOM ASSEMBLY
SCALE: 1" = 1'-0"

DRAFTING NOTE:

MOVED FROM SHEET 1, NO CHANGE



4 REAR CROSS TIE
SCALE: 3" = 1'-0"



8 ADAPTER
SCALE: 3" = 1'-0"

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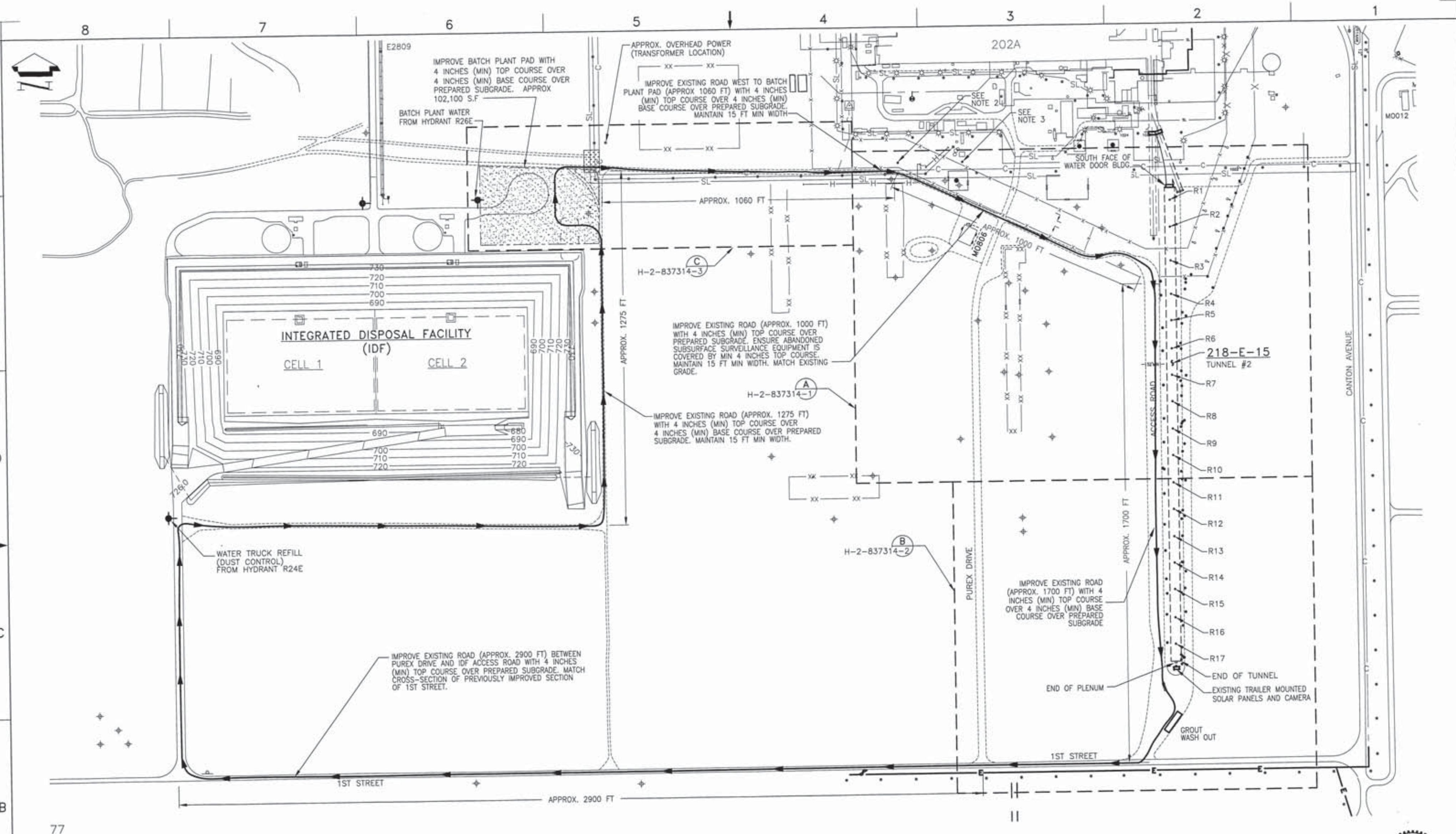
CHPRC			DESIGN CHANGE NOTICE	
BASE DOC. NO. H-2-837317	SH/PG 3	REV. 0	DCN- PUREX2-019	PAGE 23 of 27



77

SITE PLAN

SCALE: 1" = 150'

0 75 150 300 600
SCALE IN FEET

NOTES:

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. BRASS SURVEY MARKER (N39557, W48900, EL 713.00)
3. BRASS SURVEY MARKER (N39557, W48600, EL 711.99)

DWG NUMBER	TITLE
	DRAWING TRACEABILITY LIST

REF NUMBER	TITLE
H-2-837312	PUREX TUNNEL NO. 2 DWG LIST, NOTES, & LEGEND
H-2-58191	TUNNEL #2 PLOT PLAN
H-2-55586	TUNNEL #1 PLOT PLAN
REFERENCES	
NEXT USED ON H-2-837312-1	

REV NO.	DESCRIPTION
1	RELEASED PER DCN-PUREX2-019
REVISIONS	

BLDG. NO. 202A 218E15 M0806
INDEX NO. 0000 0110

CAUTION
NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

ATTENTION
DESTROY THIS DOCUMENT BY SHREDDING MAY CONTAIN SENSITIVE INFORMATION

NAME	
DRAWN BY: T. KUMAR	
R.E. BRINKLEY	
BJ HANNA	
DESIGN AUTHORITY: BJ HANNA	

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
SITE PLAN

SIZE F | DRAWING NUMBER H-2-837313 | SHEET 1 | REV 1
SCALE SHOWN
PLOTID

DRAWING LIST

DRAWING NUMBER	TITLE
H-2-837312 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION DWG LIST, NOTES, AND LEGEND
H-2-837313 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION SITE PLAN
H-2-837314 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION ENLARGED SITE PLAN
H-2-837314 SH 2	PUREX TUNNEL NO. 2 INTERIM STABILIZATION ENLARGED SITE PLAN
H-2-837314 SH 3	PUREX TUNNEL NO. 2 INTERIM STABILIZATION ENLARGED SITE PLAN
H-2-837316 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION GROUT INSERTION DEVICE
H-2-837316 SH 2	PUREX TUNNEL NO. 2 INTERIM STABILIZATION GROUT INSERTION DEVICE
H-2-837317 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION GROUT INSERTION EXT BOOM
H-2-837317 SH 2	PUREX TUNNEL NO. 2 INTERIM STABILIZATION GROUT INSERTION EXT BOOM
H-2-837317 SH 3	PUREX TUNNEL NO. 2 INTERIM STABILIZATION GROUT INSERTION EXT BOOM
H-2-837318 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION LIGHTING RACK ASSEMBLY
H-2-837310 SH 1	PUREX TUNNEL NO. 2 INTERIM STABILIZATION PASSIVE VENTILATION SKID
H-2-837310 SH 2	PUREX TUNNEL NO. 2 INTERIM STABILIZATION PASSIVE VENTILATION SKID

ABBREVIATIONS

ACI	AMERICAN CONCRETE INSTITUTE
ADDTL	ADDITIONAL
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
ALUM, AL	ALUMINUM
APPROX	APPROXIMATE
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWS	AMERICAN WELDING SOCIETY
B.O.	BOTTOM OF
BLDG	BUILDING
BM	BEAM
BOT	BOTTOM
BRG	BEARING
BTWN	BETWEEN
BTR	BUYER'S TECHNICAL REPRESENTATIVE
C	CHANNEL
CJP	COMPLETE JOINT PENETRATION
CL	CENTERLINE
CLR	CLEAR, CLEARANCE
CONC	CONCRETE
CONFIG	CONFIGURATION
CONN	CONNECTION
CONT	CONTINUOUS
COORD	COORDINATE
CTR	CENTER
CTRD	CENTERED
DBL	DOUBLE
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIR	DIRECTION
DWG	DRAWING
(E)	EXISTING
EA	EACH
EF	EACH FACE
EL	ELEVATION
ELEC	ELECTRICAL
EMBED	EMBEDMENT
ENGR	ENGINEER
EQ	EQUAL
EQ SP	EQUAL SPACING
EQUIP	EQUIPMENT
EXST	EXISTING
EXTER	EXTERIOR
EW	EACH WAY
E/W	EAST/WEST DIRECTION
FDN	FOUNDATION
FG, F.G.	FINISH GRADE
FT	FOOT, FEET
FTG	FOOTING
FV	FIELD VERIFY
GA	GAUGE
GALV	GALVANIZE
HORIZ	HORIZONTAL
HSS	HOLLOW STRUCTURAL SECTION (RECTANGULAR OR CIRCULAR)
IBC	INTERNATIONAL BUILDING CODE
ID, I.D.	INSIDE DIAMETER
IN	INCH, INCHES
INTER	INTERIOR
L	ANGLE
LBS	POUND(S)
LG	LONG
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LONG	LONGITUDINAL
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MIN	MINIMUM
MFR	MANUFACTURER
MFRD	MANUFACTURED
N	NORTH
NIC	NOT-IN-CONTRACT
NO.	NUMBER
NTS	NOT-TO-SCALE
N/S	NORTH/SOUTH DIRECTION
O TO O	OUT-TO-OUT
OC, O.C.	ON-CENTER
OD, O.D.	OUTSIDE DIAMETER
OPNG	OPENING
OPNGS	OPENINGS
OPP	OPPOSITE
PCF	POUNDS PER CUBIC FOOT
PERIM	PERIMETER
PJF	PREFORMED JOINT FILLER
PL	PLACE
PLCS	PLACES
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
R	RADIUS
REINF	REINFORCING
REQD	REQUIRED
RECT	RECTANGULAR
SCHED	SCHEDULE
SH, SHT	SHEET
SIM	SIMILAR
SP	SPACE, SPACES
SPEC	SPECIFICATION
SQ	SQUARE
SST	STAINLESS STEEL
STD	STANDARD
STRUCT	STRUCTURAL
SYMM	SYMMETRICAL
T&B	TOP AND BOTTOM
THK	THICK
T.O.	TOP OF
TOC	TOP OF CONCRETE
TOS	TOP OF STEEL
TOW	TOP OF WALL
TS	HOLLOW STRUCTURAL SECTION (RECTANGULAR OR CIRCULAR)
TRANSV	TRANSVERSE
TYP	TYPICAL
UNIF	UNIFORM, UNIFORMLY
UON, UNO	UNLESS OTHERWISE NOTED
VERT	VERTICAL
WT	WEIGHT
W/	WITH

NOTE:
FOR ABBREVIATIONS NOT LISTED, SEE ASME Y14.38 "ABBREVIATION AND ACRONYMS" PUBLICATION AS DISTRIBUTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME).

GENERAL NOTES

1. CODE: INTERNATIONAL BUILDING CODE, 2012 EDITION AS MODIFIED BY PRC-PRO-EN-097 REV 2.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFICATION OF SITE CONDITIONS, INSTALLATION STANDARDS, AND CONSTRUCTION CONDITIONS. DISCREPANCIES BETWEEN SITE CONDITION AND DESIGN DRAWINGS SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE ENGINEER-OF-RECORD.
3. WHEN DIRECTED BY THE STRUCTURAL ENGINEER SPECIAL INSPECTION AND TESTING SHALL BE PERFORMED BY AN INDEPENDENT INSPECTION/TESTING AGENCY HIRED BY THE CONTRACTOR AND APPROVED BY CHPRC. CONTRACTOR SHALL COORDINATE INSPECTION/TESTING REQUIREMENTS WITH THIS AGENCY AND CHPRC.
4. ELEVATIONS SHOWN IN THE DESIGN DRAWINGS ARE RELATIVE TO ELEVATIONS ON THE ORIGINAL DESIGN DRAWINGS.
5. DIMENSIONS SHOWN FOR EXISTING STRUCTURES AND EQUIPMENT ARE APPROXIMATE AND FOR REFERENCE ONLY. CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND ELEVATIONS PRIOR TO FABRICATION AND CONSTRUCTION. VARIATIONS BETWEEN EXST DIMENSIONS AND/OR ELEVATIONS AND THE DESIGN DRAWINGS SHALL BE PROMPTLY REPORTED TO THE ENGINEER-OF-RECORD.
6. UNLESS OTHERWISE NOTED OR DIRECTED BY CHPRC, CONTRACTOR SHALL BE RESPONSIBLE TO RETAIN AND PROTECT EXISTING TUNNEL SYSTEM TO REMAIN INCLUDING STRUCTURAL SUPPORT SYSTEM, PIPE RISERS, WATER-FILLED DOOR, VENT SHAFT, AND OVERBURDEN.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK RELATED TO CONSTRUCTION, ERECTION METHODS, BRACING, SHORING, RIGGING, GUYS, SCAFFOLDING, FORMWORK, ETC. REQUIRED TO SAFELY PERFORM THE WORK.
8. CONTRACTOR SHALL PROVIDE TEMPORARY BRACING AS REQUIRED TO MAINTAIN STABILITY DURING CONSTRUCTION.
9. DATUM: EL 744'-6" = TOC ROOF SLAB AT SOUTHWEST CORNER OF TUNNEL 2 NORTH WATER-FILLED DOOR CONCRETE SUPPORT STRUCTURE. CONTRACTOR SHALL ESTABLISH ELEVATION CONTROL FROM EXST GROUND MOUNTED BRASS SURVEY MARKER BASED ON DATUM ELEVATION.

DESIGN CRITERIA

1. LIVE LOAD: 25 PSF CONSTRUCTION LOAD
2. WIND LOAD (ULTIMATE): 110 MPH WIND SPEED (3-SEC GUST), EXPOSURE C
3. SOIL:
   - ALLOWABLE BEARING PRESSURE: 1500 PSF
   - LATERAL EARTH PRESSURE EQUIVALENT FLUID PRESSURE
     (AT-REST CONDITION):
     55 PSF/FT EXST TUNNEL SOIL COVER
     63 PSF/FT GRANULAR FILL
     0.5 AT-REST LATERAL EARTH PRESSURE COEFFICIENT
   - SOIL UNIT WEIGHT: 110 PCF TUNNEL COVER SOIL
     125 PCF GRANULAR FILL (AVERAGE MOIST UNIT WT)
4. STRUCTURE PERFORMANCE CATEGORY: PC-1, GENERAL SERVICE IN ACCORDANCE WITH PRC-PRO-EN-097, ENGINEERING DESIGN AND EVALUATION (NATURAL PHENOMENA HAZARD), REV 2.

EARTHWORK

1. CONTRACTOR SHALL BE RESPONSIBLE FOR DETERMINING THE SLOPE OF ALL EXCAVATIONS WHEN REQUIRED (1.5:1 MINIMUM HORIZONTAL-TO-VERTICAL UNLESS APPROVED BY THE STRUCTURAL ENGINEER) BASED ON THE TYPE AND CONDITION OF SOIL ENCOUNTERED AND FOR CONFORMING TO ALL LOCAL, STATE, AND FEDERAL REQUIREMENTS, INCLUDING DOE-0344, HANFORD SITE EXCAVATING, TRENCHING AND SHORING PROCEDURE.
2. AT-REST LATERAL EARTH PRESSURE COEFFICIENTS:
   - $K_o = 0.50$ HORIZONTAL GROUND SURFACE
   - $K_{oi} = K_o*[1+\sin(\theta)]$ SLOPING GROUND SURFACE (θ = SLOPE OF GROUND SURFACE IN DEGREES)
3. AVERAGE MOIST UNIT WEIGHT OF EXST TUNNEL COVER 110 PCF.
4. GROUNDWATER TABLE IS MORE THAN 300 FT BELOW PROJECT SITE.
5. MATERIALS:
   - BASE COURSE SHALL CONFORM TO WSDOT M41-10 SECTION 9-03.9(3).
   - TOP COURSE SHALL CONFORM TO WSDOT M41-10 SECTION 9-03.9(3) OR MAINTENANCE ROCK CONFORMING TO WSDOT M41-10 SECTION 9-03.9(4).
6. CLEAR AND GRUB ALL IMPROVEMENT AREAS SHOWN ON SITE PLAN. PLACE STRIPPINGS IN GOVERNMENT FURNISHED CONTAINERS FOR REMOVAL BY OTHERS.
7. UNIFORMLY MOISTEN OR AERATE SUBGRADE AND EACH SUBSEQUENT LAYER OF BASE COURSE AND TOP COURSE BEFORE COMPACTION TO WITHIN TWO (2) PERCENT OF OPTIMUM MOISTURE CONTENT. REMOVE AND REPLACE, OR SCARIFY AND AIR DRY, OTHERWISE SATISFACTORY SOIL MATERIAL THAT EXCEEDS OPTIMUM MOISTURE CONTENT BY MORE THAN TWO (2) PERCENT.
8. VIBRATORY EQUIPMENT SHALL NOT BE USED TO PROVIDE COMPACTION. ALL COMPACTION SHALL BE PERFORMED WITH PNEUMATIC AND SMOOTH DRUM ROLLERS (WITHOUT VIBRATION). COMPACT WITH 15-20 TON, SELF-PROPELLED, PNEUMATIC ROLLER A MINIMUM OF FOUR OVERLAPPING PASSES. ALTERNATELY, COMPACTION MAY BE PERFORMED WITH A 25-35 TON, SELF-PROPELLED, SMOOTH DRUM ROLLER WITH VIBRATORY CAPABILITY REMOVED. MAXIMUM RATE OF ROLLER TRAVEL SHALL NOT EXCEED 8 MPH. AFTER FINAL COMPACTION OF TOP COURSE, THE ENTIRE SURFACE SHALL BE ROLLED WITH A SMOOTH-WHEELED ROLLER. ROLLING SHALL CONTINUE UNTIL THE ENTIRE ROADWAY SURFACE PRESENTS A FIRM, DAMP, AND UNYIELDING SURFACE.
9. SCARIFY, MOISTURE CONDITION, AND COMPACT EXISTING SUBGRADE PRIOR TO PLACING BASE COURSE OR TOP COURSE.
10. PLACE BASE COURSE ON SUBGRADES FREE OF MUD, FROST, SNOW, OR ICE. ON PREPARED SUBGRADE, PLACE BASE COURSE LAYERS IN (LOOSE) THICKNESS NOT TO EXCEED SIX (6) INCHES. AREA OF PREPARED BASE COURSE SHALL BE SUFFICIENT TO PROVIDE FINAL ROAD WIDTHS SHOWN ON THE SITE PLAN. COMPACTED BASE COURSE SHALL BE A MINIMUM 4-INCH IN THICKNESS.
11. PLACE TOP COURSE ON PROOF ROLLED BASE COURSE OR SUBGRADE FREE OF MUD, FROST, SNOW, OR ICE. COMPACT AND ROLL TOP COURSE AS A FINISHED DRIVABLE SURFACE PROVIDING ROAD WIDTHS AS SHOWN ON SITE PLAN. COMPACTED TOP COURSE SHALL BE A MINIMUM 4-INCH IN THICKNESS. PLACE TOP COURSE LAYERS IN (LOOSE) THICKNESS NOT TO EXCEED SIX (6) INCHES.
12. FIELD QUALITY CONTROL:
    - ALLOW INSPECTION AGENCY TO OBSERVE SUBGRADE PREPARATION AND PLACEMENT OF EACH LAYER. PROCEED WITH SUBSEQUENT EARTH MOVING ONLY AFTER PREVIOUSLY COMPLETED WORK COMPLIES WITH REQUIREMENTS.

EARTHWORK (continued)

- PROOF-ROLL HAUL ROAD SUBGRADE WITH A FULLY LOADED (20 TON MINIMUM) TANDEM AXLE DUMP TRUCK TO IDENTIFY SOFT POCKETS AND AREAS OF EXCESS YIELDING. DO NOT PROOF-ROLL WHEN SUBGRADE IS WET OR SATURATED. SOFT POCKETS SHALL BE REMOVED AND REPLACED WITH COMPACTED BASE COURSE MATERIAL. REMOVALS DEEPER THAN 12-INCHES SHALL BE APPROVED BY BTR PRIOR TO EXCAVATION. RECONSTRUCT SUBGRADES DAMAGED BY FREEZING TEMPERATURES, FROST, RAIN, ACCUMULATED WATER, OR CONSTRUCTION ACTIVITIES, DURING HAUL ROAD CONSTRUCTION, AS DIRECTED BY BTR.
- WHEN INSPECTION AGENCY REPORTS THAT SUBGRADES, FILLS, OR BACKFILLS HAVE NOT MET PROOF ROLLING REQUIREMENTS OR ARE NOT RESULTING IN A FIRM AND UNYIELDING SURFACE, SCARIFY AND MOISTEN OR AERATE, OR REMOVE AND REPLACE SOIL MATERIALS TO DEPTH REQUIRED; RE-COMPACT UNTIL A FIRM AND UNYIELDING SURFACE IS OBTAINED.
- INSPECTION AGENCY SHALL DOCUMENT SOIL CONDITION, ESTIMATED QUANTITY PLACED, LOOSE LIFT THICKNESS, AND FINAL COMPACTED LIFT THICKNESS. INSPECTION AGENCY SHALL ALSO DOCUMENT COMPACTION EQUIPMENT, NUMBER OF PASSES OF EQUIPMENT PER LIFT, AND AVERAGE SPEED OF EQUIPMENT.

13. PROTECTION:
    - WHERE HAUL ROAD SURFACES BECOME ERODED, RUTTED, SETTLED, OR WHERE THEY LOSE COMPACTION DUE TO SUBSEQUENT CONSTRUCTION OPERATIONS OR WEATHER CONDITIONS DURING CONSTRUCTION, REPAIR/REGRADE AT DIRECTION OF BTR.

ENGINEERED GROUT

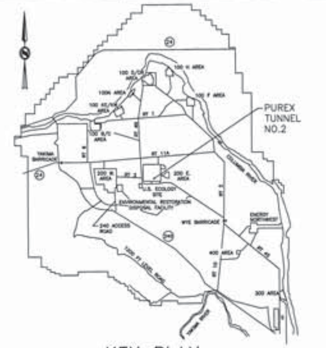
1. ENGINEERED GROUT FILLING OF THE TUNNEL INTERIOR IS FOR THE PURPOSE OF STABILIZATION AND SUPPORT OF THE EXST TUNNEL STRUCTURE AND FOR STABILIZATION AND CONTAINMENT OF CONTAMINATED EQUIPMENT LOCATED WITHIN THE TUNNEL.
2. UNLESS OTHERWISE APPROVED, GROUT MIX FORMULATION SHALL INCLUDE USE OF THE FOLLOWING MATERIALS:
   - CEMENT — TYPE I-II, ASTM C150 OR TYPE IL, ASTM C595
   - FLY ASH — CLASS F, ASTM C618
   - FINE AGGREGATE — NATURAL SANDS ONLY, ASTM C33 (MFRD SAND IS NOT ALLOWED)
   - WATER-REDUCING ADMIXTURE — TYPE A OR D, ASTM C494, CONTAINING NO CHLORIDES
   - SET RETARDER — MASTERSET DELVO AS MFRD BY BASF
   - WATER — CLEAN AND POTABLE CONTAINING LESS THAN 500 PPM CHLORIDES OR NON-POTABLE WATER SUPPLIED FROM LOCAL FIRE HYDRANT
3. UNLESS OTHERWISE APPROVED, GROUT PROPERTIES SHALL INCLUDE THE FOLLOWING:
   - SELF CONSOLIDATING, CAPABLE OF HORIZONTAL PLACEMENTS UP TO 200 FEET
   - WATER/CEMENT RATIO (W/C) — 0.60 FOR GROUT MIX DESIGN
   - SPREAD — 28 INCH MIN DIAMETER UNLESS OTHERWISE APPROVED BY THE STRUCTURAL ENGINEER, ASTM C1611
   - MINIMUM COMPRESSIVE STRENGTH — 2000 PSI AT 28-DAYS
   - CAPABLE OF ENTERING AND FILLING OPENINGS AND VOIDS WITH 1/2 INCH MINIMUM DIMENSION
   - CAPABLE OF PLACEMENT FOR UP TO 3 HOURS MIN AFTER ADDING CEMENT TO WATER, DEMONSTRATED THROUGH DOCUMENTED TRIAL BATCH TESTING
4. GROUT MIX DESIGN SHALL BE DEVELOPED IN COLLABORATION WITH THE STRUCTURAL ENGINEER AND DEMONSTRATED TO MEET DESIGN AND CONSTRUCTION PROJECT REQUIREMENTS THROUGH A MINIMUM OF (2) TWO DOCUMENTED TRIAL BATCH TESTING THAT ARE WITNESSED, REVIEWED, AND APPROVED BY THE STRUCTURAL ENGINEER.
5. TRIAL BATCH TESTING SHALL BE PERFORMED AS DIRECTED BY THE STRUCTURAL ENGINEER AND SHALL INCLUDE THE FOLLOWING:
   - MINIMUM FLOW — 80 LINEAR FEET HORIZONTALLY WITHOUT SEGREGATION
   - TEMPERATURE — ASTM C1064
   - TIME OF SET — FINAL SET TIME
   - DENSITY — ASTM C642
   - COMPRESSIVE STRENGTH — ASTM C39 USING 4" DIA x 8" TEST CYLINDERS, MIN 1 PAIR CYLINDERS TESTED AT 1, 2, 3, 7 AND 28 DAYS AFTER SAMPLING
6. GROUT FIELD QUALITY CONTROL SHALL INCLUDE THE FOLLOWING:
   - PROVIDE ADEQUATE FACILITIES FOR SAFE STORAGE AND PROPER CURING OF GROUT TEST CYLINDERS ON SITE FOR FIRST 24 HOURS INCLUDING ADDITIONAL TIME AS REQUIRED BEFORE TRANSPORTING TO TEST LAB FOR CYLINDERS TO BE TESTED AT 3, 7, AND 28 DAYS.
     A. IN THE EVENT, THE 3-DAY OR 7-DAY "BREAK" IS TO BE PERFORMED ON A "NON-WORKDAY", IT MAY OCCUR THE FOLLOWING WORK DAY.
     B. IN THE EVENT GROUT IS PLACED ON A FRIDAY OR SATURDAY (OR EXTENDED WEEKEND), INITIAL CURE TIME MAY BE EXTENDED TO A MAXIMUM 72 HOURS.
   - PROVIDE GROUT FOR TESTING INCLUDING SLUMP FLOW, TEMPERATURE, UNIT WEIGHT AND MAKING OF GROUT TEST CYLINDERS AFTER FIELD ADDITION OF SUPERPLASTICIZERS AND WORKABILITY-RETAINING ADMIXTURES.
   - MINIMUM OF ONE SET OF GROUT SAMPLES (2 CYLINDERS) SHALL BE CAST AND TESTED FOR EVERY 170 CUBIC YARDS PLACED PER DAY, WITH SAMPLES TAKEN FROM RANDOMLY SELECTED TRUCKS. FREQUENCY OF TESTING MAY BE INCREASED AT DISCRETION OF STRUCTURAL ENGINEER. VISUAL INSPECTION OF EACH TRUCK SHALL BE PERFORMED BY THE STRUCTURAL ENGINEER (OR DESIGNATED REPRESENTATIVE) TO VISUALLY CONFIRM GROUT FLOWABILITY CHARACTERISTICS ARE CONSISTENT WITH GROUT TRIAL BATCH TEST RESULTS.
   - TESTING SHALL BE PERFORMED IN ACCORDANCE WITH:
     ASTM C1611 SLUMP FLOW
     ASTM C1064 TEMPERATURE
     ASTM C138 UNIT WEIGHT, YIELD
     ASTM C39 COMPRESSIVE STRENGTH

STEEL

1. UNLESS OTHERWISE NOTED OR APPROVED, STRUCTURAL STEEL AND FASTENERS SHALL CONFORM TO AS NOTED ON FABRICATION DRAWINGS.

WELDING

1. UNLESS OTHERWISE NOTED OR APPROVED, WELDING SHALL BE PERFORMED IN ACCORDANCE WITH APPLICABLE SPECIFICATIONS AND CODES OF THE AMERICAN WELDING SOCIETY (AWS).



KEY PLAN
SCALE: NONE

LEGEND

	ECOLOGY BLOCK
	FIRE HYDRANT
	PARKING BLOCK
	POWER POLE GUY ANCHOR
POLE NO.	POWER POLE
XFMR NO.	POLE MOUNTED TRANSFORMER
	SLOPE (IN PLAN)
X	SLOPE (IN ELEVATION)
	WORK POINT
V	VAULT
	CAMERA TOWER
	SURVEILLANCE EQUIPMENT
	ITEM TO BE REMOVED
	SIGN AND/OR T-POST
	SIGN AND/OR T-POST
	LIGHT POLE
	BURIAL GROUND MARKER POST
	CONCRETE
	EARTHEN FILL
	EARTH
	WOOD
——X——	SECURITY FENCE
– – – –	UNPAVED ROAD
————	PAVED ROAD
——XX——	HAZARDOUS AREA FENCE
——SL——	STREET LIGHT POWER LINE
——C——	13.8KV DISTRIBUTION LINE
——H——	OVERHEAD SECONDARY POWER LINE
——STM——	STEAM LINE
	GROUT TRUCK ROUTE

H-2-837293	CONSTR TRAILER SITE PLAN	
REF NUMBER	TITLE	REFERENCES
NEXT USED ON	END ITEM	
DWG NUMBER	TITLE	DRAWING TRACEABILITY LIST

REV	DESCRIPTION
1	RELEASED PER DCN-PUREX2-019

REVISIONS

BLDG NO. 202A 218E15
INDEX NO. 0000 0100

CAUTION
NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

NAME
RC BRINKLEY
J KUMAR
BJ HANNA

DESIGN AUTHORITY: BJ HANNA

ATTENTION
DESTROY THIS DOCUMENT BY SHREDDING
MAY CONTAIN SENSITIVE INFORMATION

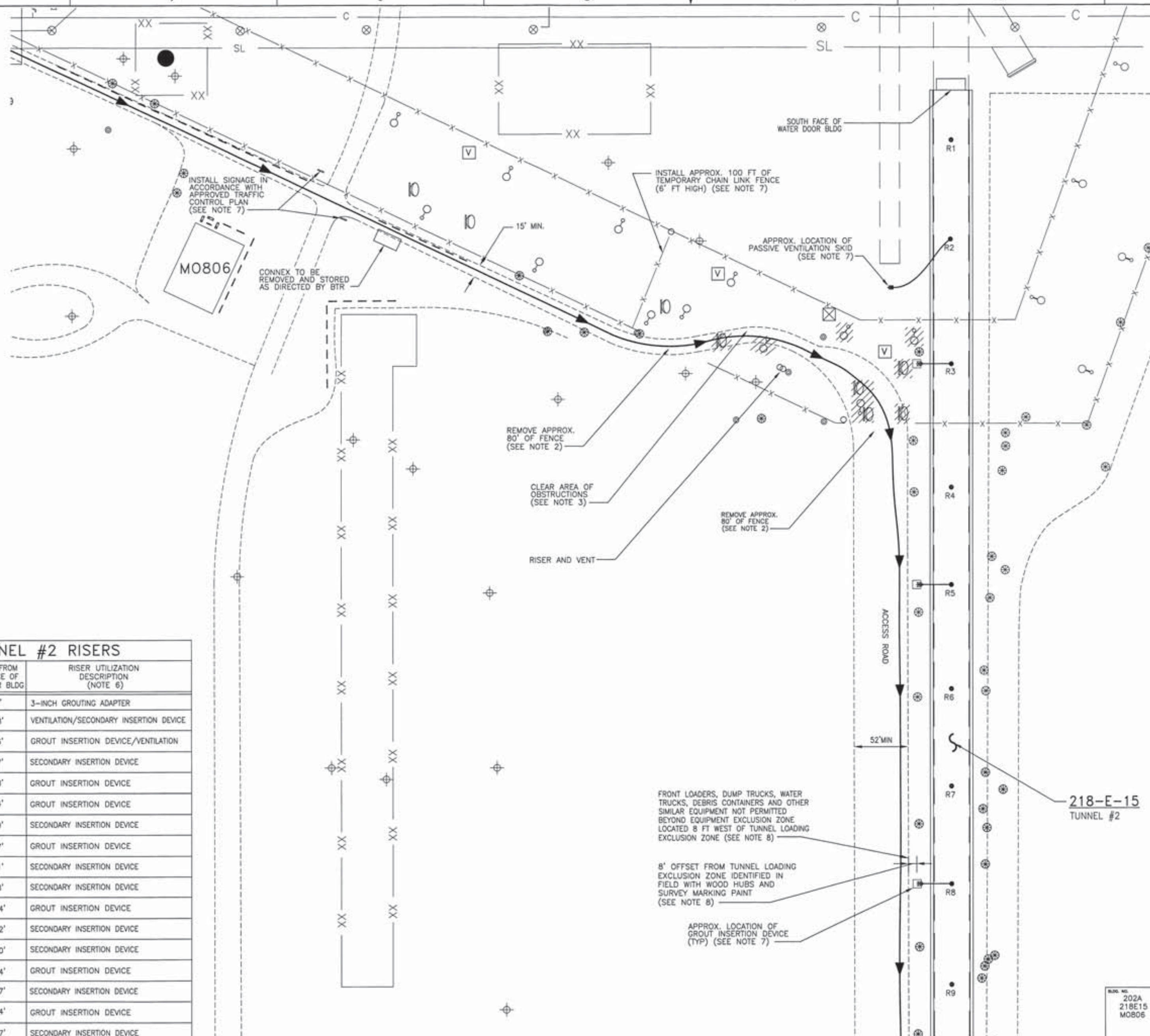
U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
DWG LIST, NOTES, AND LEGEND

SIZE F | DRAWING NUMBER H-2-837312 | SHEET 1 | REV 1
SCALE SHOWN
PLOTID

NOTES:

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. ROLL CHAIN LINK FABRIC OUT OF HARMS WAY. REMOVE POST AND SAVE. SAVE ALL PARTS FOR REINSTALLATION.
3. CLEAR AREA TO INCLUDE:
   A. REMOVE LIGHT POSTS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. UNBOLT POSTS, SIZE REDUCE TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINER FOR DISPOSAL BY OTHERS. CUT AND CAP CONDUCTORS. CUT OFF BOLTS AND CONDUIT FLUSH WITH CONCRETE, AND INSTALL CONDUIT PLUG/CAP. ENSURE TOP COURSE COVERS CONCRETE TO PROVIDE LEVEL AND SAFE DRIVING SURFACE. ABANDON-IN-PLACE CONCRETE FOOTINGS.
   B. REMOVE SURVEILLANCE EQUIPMENT UNITS INDICATED ON DRAWING. VERIFY ABSENCE OF VOLTAGE PRIOR TO REMOVAL. CUT AND CAP CONDUCTORS. CUT EQUIPMENT SUPPORTS AND CONDUIT 6 INCHES BELOW GRADE (MAX), INSTALL CONDUIT PLUG/CAP, AND ABANDON-IN-PLACE. SIZE REDUCE DEBRIS TO NO LONGER THAN 6 FEET, AND PLACE IN CONTAINERS FOR DISPOSAL BY OTHERS. ENSURE TOP COURSE COVERS ABANDONED SUPPORTS AND CONDUITS TO PROVIDE LEVEL AND SAFE DRIVING SURFACE.
4. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.
   A. RISER 3: INSTALL A 10 FT (MIN) BY 10 FT (MIN) BY APPROXIMATELY 14 INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.
   B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10 FT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.
5. INSTALL PTZ-70 CAMERA, THEN LIGHT. LIGHT SHALL HANG AT LEAST 12 INCHES BELOW CAMERA HEAD. USE CABLE TIES TO ATTACH CABLES TO LIFTING BAIL. RUBBER MATTING WITH SLIT WILL BE USED IN CONJUNCTION WITH TAPE TO SEAL OFF OPENING. CAMERA AND LIGHT WILL BE POSITIONED AT DIRECTION OF ENGINEERING.
6. RISER UTILIZATION SHALL BE IN ACCORDANCE WITH MEMORANDUM #CP-ENG-0004 (LATEST REVISION) DURING THE COMPLETION (I.E. TOPPING OFF) PHASE. ENGINEERING SHALL DOCUMENT INITIATION OF TOPPING OFF PHASE WITH A WORK RECORD ENTRY.
7. REMOVE UPON COMPLETION OF GROUTING ACTIVITIES AS DIRECTED BY BTR.
8. EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE NOT APPLICABLE UPON COMPLETION OF GROUTING ACTIVITIES/TUNNEL STABILIZATION.



TUNNEL #2 RISERS

RISER NO.	NOTE	DISTANCE FROM SOUTH FACE OF WATER DOOR BLDG	RISER UTILIZATION DESCRIPTION (NOTE 6)
1	4,5	47.17'	3-INCH GROUTING ADAPTER
2	1,3	141.18'	VENTILATION/SECONDARY INSERTION DEVICE
3	1,2	264.66'	GROUT INSERTION DEVICE/VENTILATION
4	3	383.97'	SECONDARY INSERTION DEVICE
5	2	478.08'	GROUT INSERTION DEVICE
6	2	578.64'	GROUT INSERTION DEVICE
7	3	672.79'	SECONDARY INSERTION DEVICE
8	2	767.37'	GROUT INSERTION DEVICE
9	3	864.71'	SECONDARY INSERTION DEVICE
10	3	959.18'	SECONDARY INSERTION DEVICE
11	2	1056.74'	GROUT INSERTION DEVICE
12	3	1151.12'	SECONDARY INSERTION DEVICE
13	3	1248.60'	SECONDARY INSERTION DEVICE
14	2	1342.64'	GROUT INSERTION DEVICE
15	3	1436.97'	SECONDARY INSERTION DEVICE
16	2	1537.64'	GROUT INSERTION DEVICE
17	3	1631.87'	SECONDARY INSERTION DEVICE

1. DETAIL 15, H-2-837310, SHT 2
2. DETAIL 1, H-2-837316, SHT 1
3. DETAIL 6, H-2-837316, SHT 2
4. NOTE 5, H-2-837314, SHT 1
5. DETAIL 1, H-2-837319, SHT 1 (UPON COMPLETION OF GROUTING ACTIVITIES, REMOVE ADAPTER, CUT OR DRIVE WEDGE ANCHORS FLUSH WITH CONCRETE, AND REINSTALL STEEL PLUG.)

A ENLARGED SITE PLAN
H-2-837313-1 SCALE: 1" = 40'

DWG NUMBER	TITLE
DRAWING TRACEABILITY LIST	

REF NUMBER	TITLE
H-2-837312	PUREX TUNNEL NO. 2 DWG LIST, NOTES, & LEGEND
H-2-837293	CONSTR TRAILER SITE PLAN
H-2-58191	TUNNEL #2 PLOT PLAN
H-2-55586	TUNNEL #1 PLOT PLAN

REFERENCES
NEXT USED ON H-2-837313-1

REV	DESCRIPTION
2	REVISED PER DCN-PUREX2-019

REVISIONS

BLDG. NO. 202A 218E15 M0806
INDEX NO. 0000 0110

CAUTION
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ATTENTION
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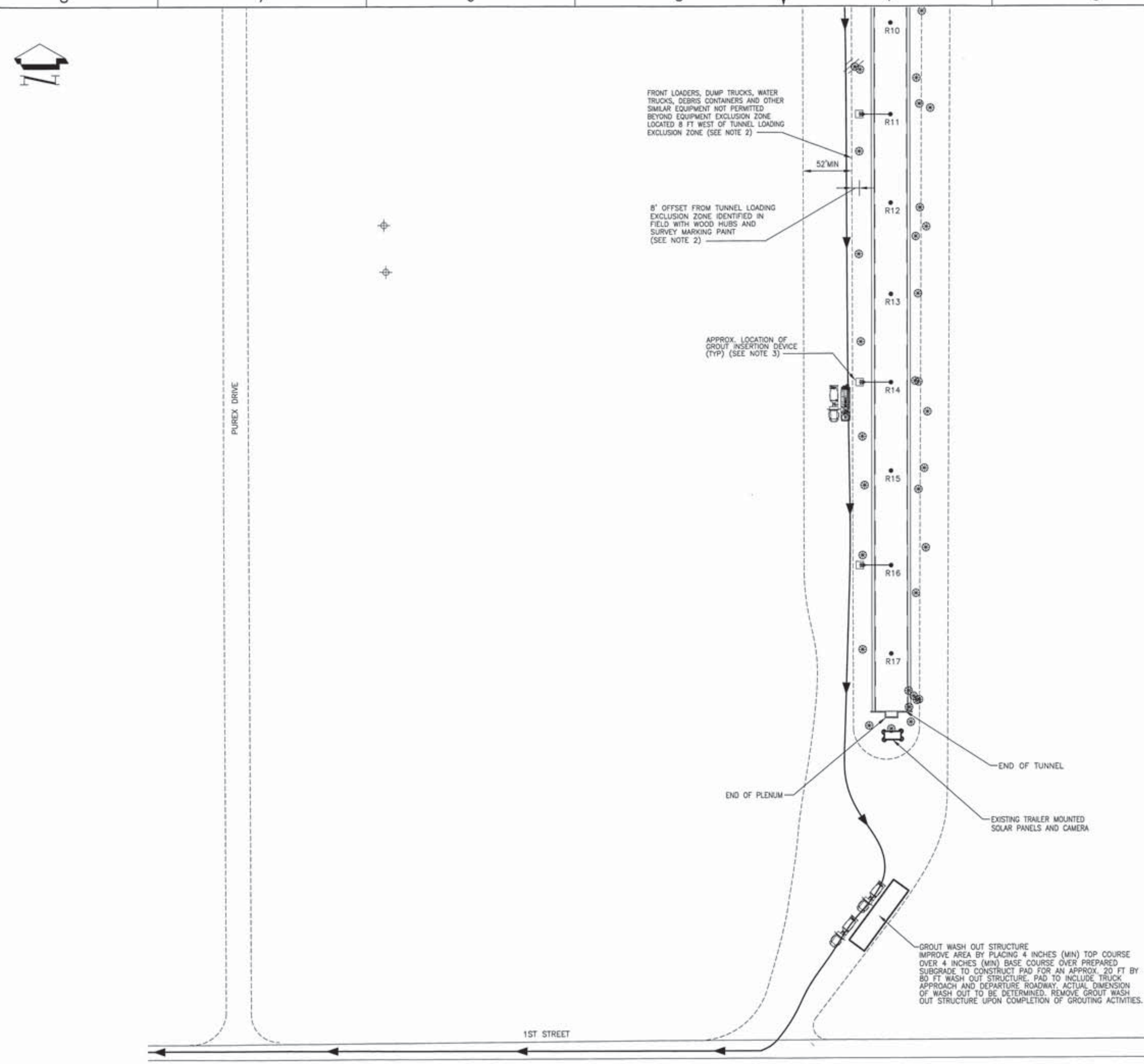
NAME
J KUMAR
RC BRINKLEY
BJ HANNA
DESIGN AUTHORITY BJ HANNA

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
ENLARGED SITE PLAN

SIZE F | DRAWING NUMBER H-2-837314 | SHEET 1 | REV 2
SCALE SHOWN
PLOTID



(B) ENLARGED SITE PLAN
H-2-837313-1 SCALE: 1" = 45'

NOTES:

1. CONSTRUCT LEVEL GRAVEL PADS AT ALL FUTURE GROUT INSERTION DEVICE LOCATIONS (I.E., RISERS 3, 5, 6, 8, 11, 14, 16). PADS SHALL BE CONSTRUCTED OF TOP COURSE MATERIAL. HEAVY EQUIPMENT, INCLUDING COMPACTION EQUIPMENT, SHALL NOT BE PERMITTED BEYOND THE EQUIPMENT EXCLUSION ZONE. SCRAPE AND/OR DRAG MATERIAL TO FORM LEVEL FINISH SURFACE.
   A. RISER 3: INSTALL A 10-FOOT (MIN) BY 10-FOOT (MIN) BY APPROXIMATELY 14-INCH HIGH PAD. PAD FINISH GRADE SHALL MATCH ELEVATION OF TUNNEL LOADING EXCLUSION ZONE.
   B. RISERS 5, 6, 8, 11, 14, 16: INSTALL 10-FOOT WIDE (MIN) PAD BETWEEN THE EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE. PAD FINISH GRADE SHALL MATCH ELEVATION OF ADJACENT GRAVEL ROAD.
2. EQUIPMENT EXCLUSION ZONE AND TUNNEL LOADING EXCLUSION ZONE NOT APPLICABLE UPON COMPLETION OF GROUTING ACTIVITIES/TUNNEL STABILIZATION.
3. REMOVE UPON COMPLETION OF GROUTING ACTIVITIES AS DIRECTED BY BTR.

12-5-19

DWG NUMBER	TITLE	REF NUMBER	TITLE
		SEE SHEET 1	
DRAWING TRACEABILITY LIST		NEXT USED ON H-2-837313-1	REFERENCES

REV NO.	DESCRIPTION
2	REVISED PER DCN-PUREX2-019
	REVISIONS

BLDG. NO. 202A 218E15
INDEX NO. 0000 0110

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	NAME
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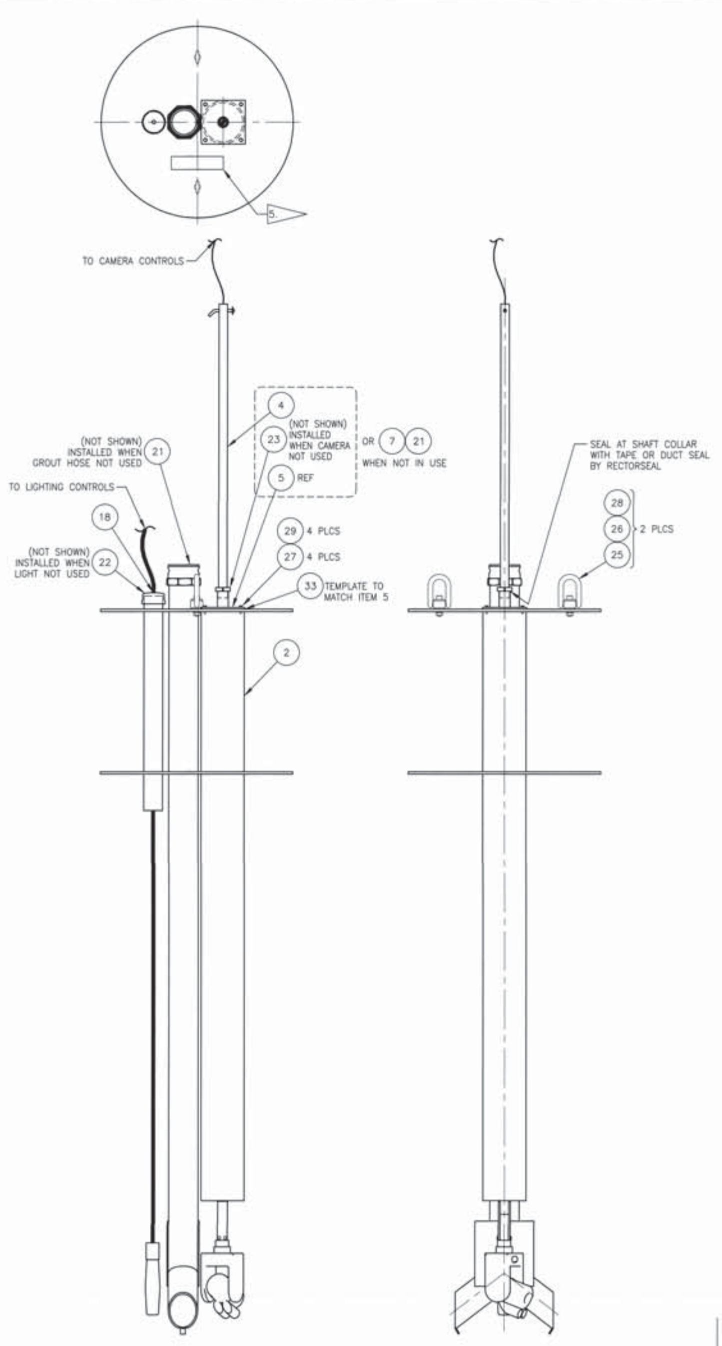
	RC BRINKLEY
	BJ HANNA
DESIGN AUTHORITY	BJ HANNA

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
ENLARGED SITE PLAN

SIZE F | DRAWING NUMBER H-2-837314 | SHEET 2 | REV 2
SCALE SHOWN



1 GROUT INSERTION DEVICE
SCALE: 1 1/2" = 1'-0"

NOTES: (UNLESS OTHERWISE NOTED)

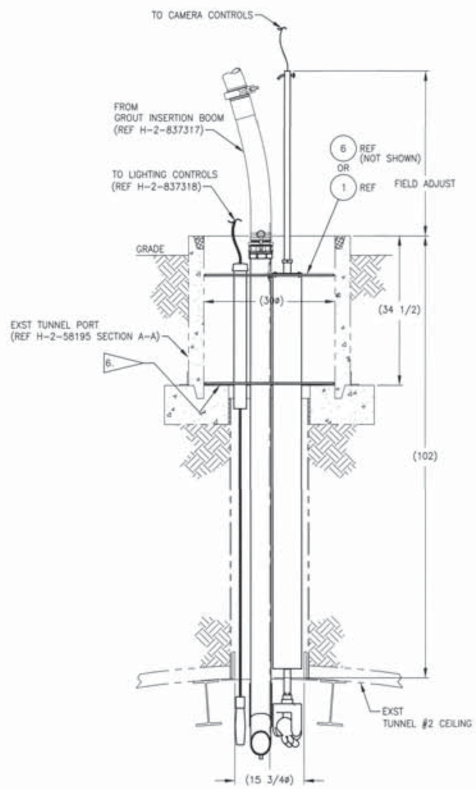
1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. DIMENSIONS AND TOLERANCES SHALL BE PER ANSI/ASME Y14.5-2009. ALL DIMENSIONS ARE IN INCHES. TOLERANCES ARE AS FOLLOWS, UNLESS OTHERWISE NOTED:

   DECIMAL: .X=±.1, .XX=±.03, .XXX=±.010
   FRACTIONAL: ±1/8
   ANGULAR: ±1 DEGREES
   MACHINED RADII: .02 MAXIMUM
3. BREAK ALL SHARP EDGES AND REMOVE ALL BURRS.
4. ALL WELDING AND INSPECTION OF SHALL BE IN ACCORDANCE WITH AWS D1.1 OR D1.6, AS APPLICABLE. VT FINAL PASS ON ALL WELDS. USE OF ASME B&PVC SECTION IX PROCEDURES AND QUALIFICATIONS IS ACCEPTABLE.

5. AFTER FINAL FABRICATION LABEL ASSEMBLY WITH 1/2" HIGH WHITE CHARACTERS ON A BLACK BACKGROUND. THE USE OF EITHER VINYL SHEET AND LETTERING OR ACRYLIC ENAMEL, ACRYLIC URETHANE, OR AN CHPRC APPROVED ALTERNATE PAINT IS ACCEPTABLE. LABEL INFORMATION SHALL BE AS FOLLOWS:
   DRAWING NUMBER, DASH NUMBER, AND ACTUAL WEIGHT.

6. USE POLYURETHANE FOAM SHEET, 1/2" THK, OR APPROVED EQUAL, AT INSTALLATION IN THE FIELD TO CREATE A SEAL WITH EXISTING TUNNEL RISER.

7. ITEMS ABOVE LOWER FLANGE (ITEM 43) ONLY USED FOR GROUT ADDITION AND ARE REMOVED AT COMPLETION AND REPLACED WITH BLIND FLANGE (ITEM 44).



GROUT INSERTION DEVICE INSTALLATION
SCALE: 1" = 1'-0"

PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	-070	-060	-050	-040	-030	-020	-010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3									-010	GROUT INSERTION DEVICE	(QTY = 3 TOTAL)	1	1
GS/QL3								1	-020	INSERTION WELDMENT	(QTY = 3 TOTAL)	2	2
GS/QL3							1		-030	GROUT DIVERTER	(QTY = 3 TOTAL)	2	3
GS/QL3								1	-040	CAMERA ASSEMBLY	(QTY = 3 TOTAL)	2	4
GS/QL3					1				-050	CAMERA GUIDE	(QTY = 3 TOTAL)	2	5
GS/QL3									-060	SECONDARY INSERTION DEVICE	(QTY = 1 TOTAL)	2	6
GS/QL3									-070	CAMERA PORT GROUTING ASSEMBLY		2	7
GS/QL3			AR				AR			PLATE, 3/8" THK MIN	ASTM A36		8
GS/QL3				AR						PLATE, 1/4" THK	ASTM A36		9
GS/QL3				AR		AR				PLATE, 3/16" THK	ASTM A36		10
GS/QL3					AR					PLATE, 1/4" THK	ASTM A240 TYPE 316		11
GS/QL3							AR			PIPE, 6", SCH 40	ASTM A53 ANY GR		12
GS/QL3						AR				PIPE, 4", SCH 40	ASTM A53 ANY GR		13
GS/QL3							AR			PIPE, 2 1/2", SCH 40	ASTM A53 ANY GR		14
GS/QL3				AR						PIPE, 1 1/2", SCH 40	ASTM A53 ANY GR		15
GS/QL3					AR					TUBE, 1 1/2" OD X 16 GA WALL	ANY 300 GR SST		16
GS/QL3									-080	RISER 2, 3" GROUTING ADAPTER		2	17
GS/QL3								1	H-2-837318-010	LIGHTING RACK ASSEMBLY			18
GS/QL3					1			1	PTZ140	CAMERA WITH LIGHTS AND CONTROL UNIT	GE SENSING & INSPECTION TECHNOLOGIES		19
GS/QL3							1		400-A-SS	CAMLOCK, 4" MALE x FNPT, TYPE A	DIXON		20
GS/QL3								AR	400-DC-SS	DUST CAP, 4" MALE	DIXON		21
GS/QL3								1		CAP, 2 1/2" THD, CL 150	ASME B16.3 CS		22
GS/QL3								1		CAP, 1 1/2" THD, CL 150	ASME B16.3 CS		23
GS/QL3	1									REDUCER, 5" x 3", CC, BW, SCH 40	ASME B16.9, ASTM A234 CS		24
GS/QL3			2					2	46602	EYEBOLT, SWIVEL, 2500# WLL	ACTEK		25
GS/QL3			2					2		NUT, HEAVY HEX, 1/2-13UNC-2B	ASTM A563 GR B		26
GS/QL3								4		HHCS, 1/4-20UNC-2A x 1" LG	ASTM A193 GR B7		27
GS/QL3			2					2		WASHER, 1/2" NOMINAL, FLAT	ASTM F436		28
GS/QL3								4		WASHER, 1/4" NOMINAL, FLAT	ANY GRADE CS		29
GS/QL3					4					HHCS, 1/4-20UNC-2A x 1/2" LG	ASTM A193 GR B7		30
GS/QL3					1				(90146A067)	CLEVIS PIN, 3/8" DIA, w/COTTER PIN, 2 1/2" USABLE LENGTH, ZINC-PLATED	(McMASTER-CARR)		31
GS/QL3					1				(6435K23)	CLAMPING SHAFT COLLAR, FOR 1 1/2" DIA SHAFT, CS	(McMASTER-CARR)		32
GS/QL3								AR		EPDM RUBBER SHEET, 1/8" THK, DUROMETER 60A	ASTM D2000 BA		33
GS/QL3	1		1						WE500125C	WELD END, 5", HEVI-DUTY x BW	CON FORMS OR EQUAL		34
GS/QL3	1		1						C50SDL	SNAP COUPLING, 5" HEVI-DUTY	CON FORMS OR EQUAL		35
GS/QL3	1		1							HAMMER VALVE, 5" HEVI-DUTY	CON FORMS OR EQUAL		36
GS/QL3			AR							PIPE, 5", SCH 40	ASTM A53 ANY GR		37
GS/QL3			AR							PIPE, 3", SCH 40	ASTM A53 ANY GR		38
GS/QL3			1							REDUCER, 5" x 3", ECC, BW, SCH 40	ASME B16.9, ASTM A234 CS		39
GS/QL3			1							ELBOW, 5", LR, BW, SCH 40	ASME B16.9, ASTM A234 CS		40
GS/QL3			1							CAP, 3" THD, CL 150	ASME B16.3 CS		41
GS/QL3			AR							TUBING, 3/16" ID	TYGON OR EQUAL		42
GS/QL3			2							FLANGE, 5", SO, RF, CL 150	ASTM A105		43
GS/QL3			1							BLIND FLANGE, 5", RF, CL 150	ASTM A105		44
GS/QL3			1							GASKET, 5", 1/8" THK, FF, CL 150	ASTM D2000 EPDM		45
GS/QL3			8							STUD, 3/4-10UNC-2A x 3 3/4" LG	ASTM A193 GR B7		46
GS/QL3			16							NUT, HEAVY HEX, 3/4-10UNC-2B	ASTM A194 GR 7		47
GS/QL3		1							(53015K68)	CONNECTOR, 4" CAM-LOCK X 4" BARB STAINLESS STEEL	(McMASTER-CARR)		48
GS/QL3		AR								PLATE, 1/4" THICK	ASTM A240 TYPE 304		49
GS/QL3	1									3M COUPLING, 3" THD, CS	ANY GRADE CS		50
GS/QL3	1									PIPE, TOE, 3" x 6" LG, SCH 80	ASTM A106 ANY GR		51

ORIGINAL
Approved for Construction
ISSUED BY
DOCUMENT CONTROL
Date: 7/10/19

DWG NUMBER	TITLE	REF NUMBER	TITLE
		H-2-837312	PUREX TUNNEL NO. 2 DWG LIST, NOTES, & LEGEND
DRAWING TRACEABILITY LIST		REFERENCES	
		NEXT USED ON H-2-837313-1	

REV NO	DESCRIPTION
2	REVISED PER DCN-PUREX2-019
REVISIONS	

BLDG NO. 202A 218E15
INDEX NO. 9901

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NAME
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T KUMAR
KJ LEIST
DESIGN AUTHORITY KJ LEIST

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
GROUT INSERTION DEVICE

SIZE F DRAWING NUMBER H-2-837316 SHEET 1 REV 2
SCALE SHOWN
PLOTID

NOTES: (UNLESS OTHERWISE NOTED)

1. SEE H-2-837312 FOR ABBREVIATIONS, LEGEND, AND GENERAL NOTES.
2. DIMENSIONS AND TOLERANCES SHALL BE PER ANSI/ASME Y14.5-2009. ALL DIMENSIONS ARE IN INCHES. TOLERANCES ARE AS FOLLOWS, UNLESS OTHERWISE NOTED:

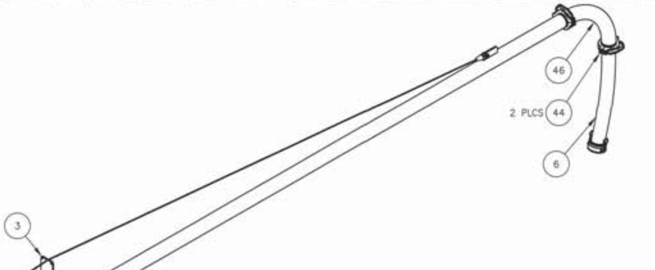
   DECIMAL: .X=±.1, .XX=±.03, .XXX=±.010
   FRACTIONAL: ±1/8 >24 ± 1/4
   ANGULAR: ±1 DEGREES
   MACHINED RADII: .02 MAXIMUM
3. BREAK ALL SHARP EDGES AND REMOVE ALL BURRS.
4. ALL WELDING AND INSPECTION OF STRUCTURAL STEEL COMPONENTS INCLUDING THE LIFTING POINTS SHALL BE IN ACCORDANCE WITH AWS D14.1 FOR CYCLICALLY LOADED STRUCTURES. VT FINAL PASS ON ALL WELDS. USE OF ASME B&PVC SECTION IX PROCEDURES AND QUALIFICATIONS IS ACCEPTABLE.
5. ALL WELDING AND INSPECTION OF PIPING COMPONENTS SHALL BE IN ACCORDANCE WITH ASME B31.3, CATEGORY NORMAL FLUID SERVICE. DESIGN PRESSURE IS 150 PSI.
6. AFTER FINAL FABRICATION LABEL ASSEMBLY WITH 1/2" HIGH WHITE CHARACTERS ON A BLACK BACKGROUND. THE USE OF EITHER VINYL SHEET AND LETTERING OR ACRYLIC ENAMEL, ACRYLIC URETHANE, OR AN CHPRC APPROVED ALTERNATE PAINT IS ACCEPTABLE. LABEL INFORMATION SHALL BE AS FOLLOWS:
   DRAWING NUMBER, DASH NUMBER, AND ACTUAL WEIGHT (ESTIMATED WEIGHT IS 5,650 LB).
7. PERFORM MT ON COMPLETED LUG WELDS PER AWS D14.1.
8. MAY BE ASSEMBLED OF EQUIVALENT COMPONENTS.
9. A 125% RATED LOAD TEST SHALL BE CONDUCTED BY APPLYING 350 LB (+17 LB / -0 LB) AT THE SPELTER PLATE POSITION. BOOM POSITION IS HORIZONTAL AND WITHOUT ELBOW OR OTHER END ATTACHMENTS. AFTER TEST, VISUALLY INSPECT LOAD PATH ELEMENTS TO ENSURE NO DISTORTION, CRACKS, OR OTHER DAMAGE.
10. SEAL THREADED CONNECTIONS ON ITEM 69 WITH LOCTITE 567 OR CHPRC APPROVED EQUAL.
11. PERFORM ULTRASONIC TESTING (UT) OF THREE BOOM ASSEMBLIES IN ACCORDANCE WITH ASTM E213. PERFORM TESTING AFTER BOOM ASSEMBLY HAS CONVEYED 2000 CUBIC YARDS AND PRIOR TO CONVEYING 4000 CUBIC YARDS.
    TESTING FREQUENCY:
    a) OBTAIN WALL THICKNESS OF 4-INCH DIAMETER SCHEDULE 40 PIPE (PART NO. 31) AT FOUR LOCATIONS ALONG EACH TESTED ASSEMBLY.
    b) OBTAIN WALL THICKNESS OF 4-INCH HEVI-DUTY 90° ELBOW (PART NO. 46) AT ONE LOCATION ALONG EACH TESTED ASSEMBLY.
    SUBMITTALS:
    a) TESTING AGENCY QUALIFICATIONS.
    b) PERSONNEL TESTING QUALIFICATIONS-INSPECTOR SHALL BE AN ASNT (AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING) NDT LEVEL II TECHNICIAN.
    c) TESTING AND INSPECTION RESULTS-REPORT TO IDENTIFY WHICH BOOM ASSEMBLY WAS TESTED, LOCATION OF TEST, AND PIPE WALL THICKNESS.

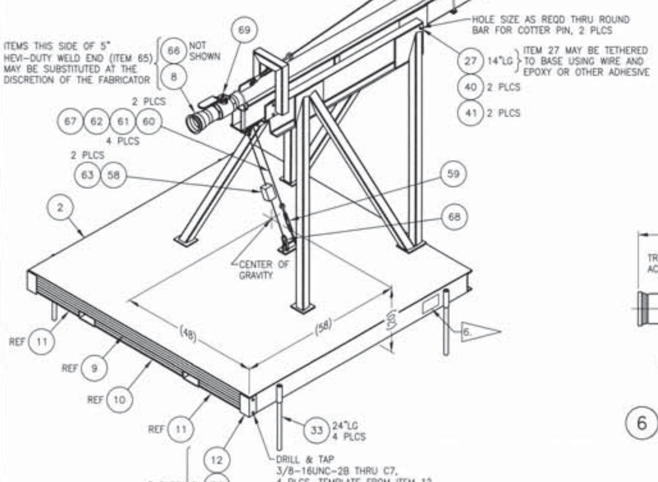
PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	-070	-060	-050	-040	-030	-020	-010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3						1			1039655	OPEN SPELTER SOCKET, FOR 1/2" WIRE ROPE, WITH CLEVIS PIN	CROSBY		55
GS/QL3						1				BOLT, HEX HD, 3/8-16UNC-2A x 7"LG	ASTM A193 GR B7		56
													57
GS/QL3								1	BAN15 SERIES	RATCHET PULLER, 3,000 LB CAPACITY	LK GOODWIN (CM)		58
GS/QL3								1	1031993	TURNBUCKLE, JAW-TO-EYE, 3,500 LB CAP, HG-227, 6" TAKE UP, STL	CROSBY		59
GS/QL3								2	1037675	WIRE ROPE THIMBLE, 3/8", G-414, STL	CROSBY		60
GS/QL3								4	1010097	WIRE ROPE SADDLE, 3/8", STL	CROSBY		61
GS/QL3								AR	(3440T66)	3/8" DIA WIRE ROPE, 6x19 IWRC CORE, 3,300 LB CAPACITY	(McMASTER-CARR) ASTM A1023		62
GS/QL3								2	1018099	SHACKLE, 1/2", G-213, 2 TON LIMIT	CROSBY		63
GS/QL3	1									REDUCER, 5"x4", CONC, BW	ASME B16.9, ASTM A234 CS		64
GS/QL3	1								WE50D125C	WELD END, 5", HEVI-DUTY x BW	CON FORMS OR EQUAL		65
GS/QL3								1	C50SDL	SNAP COUPLING, 5" HEVI-DUTY	CON FORMS OR EQUAL		66
GS/QL3								1		SHACKLE, 7/16", G-209, 1 1/2 TON LIMIT	CROSBY		67
GS/QL3								1	(589614)	MASTER LINK, 3/8", 3,300 LB LIMIT	(GUNNEBO)		68
GS/QL3								1	(45AL82)	BALL VALVE, 4" FNPT, FULL PORT, SST, 1000 PSI CWP	(GRAINGER)		69
GS/QL3	AR					AR				PIPE, 4", SCH 40, HALF NIPPLE	ASTM A53		70

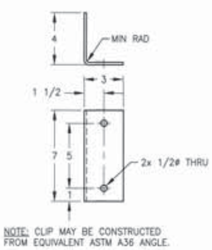
PARTS LIST/MATERIAL LIST

SC/QL	QTY -080	-070	-060	-050	-040	-030	-020	-010	PARTS / DASH NUMBER	NOMENCLATURE/DESCRIPTION	MATERIAL/REFERENCE	SHEET	ITEM NO
GS/QL3								X	-010	GROUT INSERTION BOOM	(QTY = 1 TOTAL)	1	1
GS/QL3							X	1	-020	BASE ASSEMBLY	(QTY = 1 TOTAL)	2	2
GS/QL3						X		1	-030	BOOM ASSEMBLY	(QTY = 1 TOTAL)	3	3
GS/QL3					X		1		-040	REAR CROSS TIE	(QTY = 1 TOTAL)	3	4
GS/QL3				X		1			-050	CABLE GUIDE	(QTY = 1 TOTAL)	3	5
GS/QL3			X					1	-060	HOSE ASSEMBLY	(QTY = 1 TOTAL)	1	6
GS/QL3		X				1	1		-070	HOIST PLATE		3	7
GS/QL3	X							1	-080	ADAPTOR		3	8
GS/QL3								AR	-001	COUNTERWEIGHT - TYPE 1, THK AS REQD	ASTM A36	1	9
GS/QL3								AR	-002	COUNTERWEIGHT - TYPE 2, THK AS REQD	ASTM A36	1	10
GS/QL3								AR	-003	COUNTERWEIGHT - TYPE 3, THK AS REQD	ASTM A36	1	11
GS/QL3								2	-004	WEIGHT CLIP, 3/16" THK	ASTM A36	1	12
GS/QL3						1			-005	SPELTER PLATE, 1/2" THK	ASTM A36	3	13
GS/QL3						1			-006	TURNBUCKLE PLATE, 1/2" THK	ASTM A36	3	14
													15
													16
GS/QL3						3			-009	4" U-BOLT, 1/2" DIA	ASTM A36	3	17
GS/QL3						AR				HSS 8 x 4 x 1/4	ASTM A500 GR B		18
GS/QL3							AR			HSS 7 x 3 x 1/4	ASTM A500 GR B		19
GS/QL3					AR		AR			HSS 3 x 3 x 1/4	ASTM A500 GR B		20
GS/QL3							AR			C12 x 20.7	ASTM A572 GR 50		21
GS/QL3							AR			C7 x 9.8	ASTM A572 GR 50		22
GS/QL3							AR			C4 x 7.25	ASTM A572 GR 50		23
GS/QL3							AR			C4 x 5.4	ASTM A572 GR 50		24
GS/QL3						AR				C3 x 4.1	ASTM A572 GR 50		25
													26
GS/QL3								AR		ROUND BAR, 3/4" DIA	ASTM A36		27
GS/QL3		AR								PLATE, 3/4" THK	ASTM A36		28
GS/QL3		AR		AR	AR	AR		AR		PLATE, 1/2" THK	ASTM A36		29
GS/QL3							AR			PLATE OR FLATBAR, 3/8" THK	ASTM A36		30
GS/QL3						AR				PIPE, 4", SCH 40, SMLS	ASTM A53 GR B TYPE S		31
GS/QL3							AR			PIPE, 1 1/4", SCH 40	ASTM A53 GR B		32
GS/QL3								AR		PIPE, 1", SCH 40	ASTM A53 GR B		33
GS/QL3				AR						PIPE, 1/2", SCH 40	ASTM A53 GR B		34
GS/QL3						6				BOLT, HEX HD, 3/8-16UNC-2A x 7/8"LG	ASTM A193 GR B7		35
GS/QL3								4		BOLT, HEX HD, 3/8-16UNC-2A x 5/8"LG	ASTM A193 GR B7		36
GS/QL3						12				NUT, HEX, 1/2-13UNC-2B	ASTM A194 GR 2H		37
GS/QL3						8				BOLT, HEX HD, 3/8-16UNC-2A x 1"LG	ASTM A193 GR B7		38
GS/QL3						16		4		WASHER, 3/8" NOMINAL, FLAT	ANY GRADE CS		39
GS/QL3								2		WASHER, 3/4" NOMINAL, FLAT	ANY GRADE CS		40
GS/QL3								2		COTTER PIN, 1/16" DIA (MIN) x 1 1/4"LG	ANY GRADE CS		41
GS/QL3							AR			TRACTION FLOOR PLATE, 1/4" THK	ANY GRADE CS		42
GS/QL3			1						(H40LF10DIA)	TIP HOSE, 4", HEVI-DUTY END, 150 PSI WP MIN	CON FORMS OR EQUAL		43
GS/QL3								2	C40SDL	SNAP COUPLING, 4" HEVI-DUTY	CON FORMS OR EQUAL		44
GS/QL3						1			WE40D125C	WELD END, 4" HEVI-DUTY x BW	CON FORMS OR EQUAL		45
GS/QL3								1	PB409018D	PLACING ELBOW, 4" HEVI-DUTY, 90°	CON FORMS OR EQUAL		46
										DELETED			47
GS/QL3						1				NUT, HEX, 3/8-6UNC-2B	ASTM A194 GR 2H		48
GS/QL3			1						(53015K168)	COUPLING, CAM & GROOVE, 4" BARB	(McMASTER-CARR)		49
GS/QL3						1			1032055	TURNBUCKLE, JAW-TO-EYE, 5,200 LB CAP, HG-227, 6" TAKE UP, STL	CROSBY		50
GS/QL3						1			G-411-1037354	WIRE ROPE THIMBLE, 1/2", STL	CROSBY		51
GS/QL3						2			G-450-1010131	WIRE ROPE SADDLE, 1/2", STL	CROSBY		52
GS/QL3						AR			(3440T61)	1/2" DIA WIRE ROPE, 6x19 IWBC CORE, 5,300 LB CAPACITY	(McMASTER-CARR) ASTM A1023		53
GS/QL3			2							WORM DRIVE HOSE CLAMP OR BANDING CLAMP, SIZE AS REQUIRED	ANY 300 SERIES SST		54



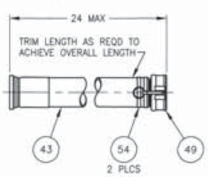


1 GROUT INSERTION BOOM
SCALE: NONE

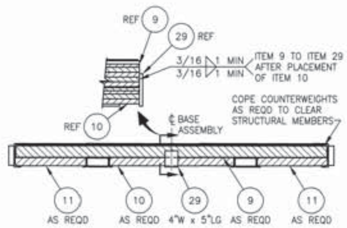


NOTE: CLIP MAY BE CONSTRUCTED FROM EQUIVALENT ASTM A36 ANGLE.

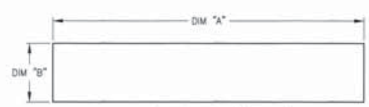
12 WEIGHT CLIP
SCALE: 3" = 1'-0"



6 HOSE ASSEMBLY
SCALE: 1 1/2" = 1'-0"



COUNTERWEIGHT LAYOUT
SCALE: 3/4" = 1'-0"



ITEM NO.	DIM A	B	*THK
9	95	18	3 1/2
10	38	18	2 1/2
11	21 1/2	18	2 1/2

NOTE:
*INDICATES TOTAL THICKNESS REQUIRED. COUNTERWEIGHTS MAY BE FABRICATED FROM ANY THICKNESS REQUIRED TO REACH TOTAL THICKNESS NOTED. SEE COUNTERWEIGHT LAYOUT (THIS SHEET) FOR FURTHER DETAILS.

9 COUNTERWEIGHT - TYPE 1
SCALE: 3/4" = 1'-0"

10 COUNTERWEIGHT - TYPE 2
SCALE: 3/4" = 1'-0"

11 COUNTERWEIGHT - TYPE 3
SCALE: 3/4" = 1'-0"

ORIGINAL
Approved for Construction
ISSUED BY
DOCUMENT CONTROL
Date 7/10/19

DWG NUMBER	TITLE
	DRAWING TRACEABILITY LIST

REF NUMBER	TITLE
H-2-837312	PURIX TUNNEL NO. 2 DWG LIST, NOTES, & LEGEND
NEXT USED ON H-2-837313-1	REFERENCES

REV NO.	DESCRIPTION
2	RELEASED PER DCN-PUREX2-019
	REVISIONS

BLDG NO. 202A 218E15
INDEX NO. 9901

CAUTION
NOT COMPLETE WITHOUT CURRENT CHANGE DOCUMENTS FROM DATABASE

ATTENTION
DESTROY THIS DOCUMENT BY SHREDDING MAY CONTAIN SENSITIVE INFORMATION

NAME
RC BRINKLEY
T KUMAR
KJ LEIST
DESIGN AUTHORITY: KJ LEIST

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

PUREX TUNNEL NO. 2
INTERIM STABILIZATION
GROUT INSERTION EXT BOOM

SIZE F | DRAWING NUMBER H-2-837317 | SHEET 1 | REV 2
SCALE SHOWN
PLOTID

Hanford Facility RCRA Permit Modification Notification Forms

Part V, Closure Unit CUG-32

276-BA Organic Storage Area

Index

Submitted by Co-Operator:		Reviewed by DOE Program Office:	
DEBORAH SINGLETON (Affiliate) Digitally signed by DEBORAH SINGLETON (Affiliate) Date: 2020.08.24 15:44:10 -07'00'		Duane B. Carter	August 24, 2020
Deborah Singleton	Date	Duane Carter	Date

Hanford Facility RCRA Permit Modification Form	
Unit: **_276-BA Organic Storage Area_**	Permit Part **_Parts I & II Standard & General Conditions_**

Description of Modification:

Changes are needed to convey the removal of 276-BA Organic Storage Area, Closure Unit Group 32 (CUG-32) requirements from the permit. Revisions are made to pages 15, 49, and 50 to show 276-BA Organic Storage Area is being retired from permit Revision 8C and to identify the date of closure (May 18, 2020, 20-NWP-089).

WAC 173-303-830 Modification Class	Class 1	Class ¹1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Other Modifications:
The permittees request that this modification be reviewed and approved as a Class 1-prime.

The permittees have completed closure activities following the Closure Plan (Addendum H) for CUG-32. Ecology accepted the certification of clean closure on May 18, 2020. (20-NWP-089)

This modification is the final step in removing requirements for the 276-BA Organic Storage Area, Closure Unit Group 32 (CUG-32) from the permit.

Modification Approved: [X] Yes [ ] No

Reviewed by Ecology:
Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.08.27 14:53:09 -07'00'

S. N. Schleif Date

Hanford Facility RCRA Permit Modification Form

Unit:	Permit Part
276-BA Organic Storage Area	***Part V, Closure Unit Group 32***

Description of Modification:

Changes are needed to retire permit requirements for the 276-BA Organic Storage Area Closure Unit Group. The following CUG-32 document and addendum are being removed from the permit:

- Closure Unit Group 32 Unit Specific Conditions
- Addendum H: Closure Plan

WAC 173-303-830 Modification Class	Class 1	Class '1	Class 2	Class 3
Please mark the Modification Class:		X		

Enter relevant WAC 173-303-830, Appendix I Modification citation number:

Other Modifications:
The permittees request that this modification be reviewed and approved as a Class 1-prime.

The permittees have completed closure activities following the Closure Plan (Addendum H) for CUG-32. Ecology accepted the certification of clean closure on May 18, 2020. (20-NWP-089)

This modification is the final step in removing requirements for the 276-BA Organic Storage Area, Closure Unit Group 32 (CUG-32) from the permit.

Modification Approved: [X] Yes [ ] No

USDOE and CHPRC agreed with Ecology removing the 276-BA Organic Storage Area unit information from Permit Attachment 9, Permit Applicability Matrix (see attached email).

Reviewed by Ecology:

Schleif, Stephanie (ECY) Digitally signed by Schleif, Stephanie (ECY) Date: 2020.08.27 14:53:46 -07'00'

S. N. Schleif Date

Revision Instructions:

Revise the Parts I and II (Standard & General Conditions) pages 15, 49 and 50 as shown herein.
Remove 276-BA (CUG-32) Unit Specific Conditions
Remove 276-BA (CUG-32) Addendum H: Closure Plan

From:	Martin, Paul W - CHPRC
To:	Carter, Duane B; Weese, Brigitte (ECY)
Cc:	Temple, John (ECY); Hall, Katie (ECY); Carlson, Annette (ECY); Cantu, Jennifer (ECY)
Subject:	RE: 276-BA Class 1 Prime
Date:	Wednesday, August 26, 2020 10:29:01 AM

CHPRC agrees!

Paul W. Martin
RCRA Subject Matter Expert
CHPRC Environmental Protection
Phone (509) 376-6620 / Cell 531-4489 / Fax 376-4336
Paul_W_Martin@RL.Gov
CH2MHill Plateau Remediation Company

From: Carter, Duane B <duane.carter@rl.doe.gov>
Sent: Wednesday, August 26, 2020 10:20 AM
To: Weese, Brigitte (ECY) <bwee461@ECY.WA.GOV>; Martin, Paul W - CHPRC <paul_w_martin@rl.gov>
Cc: Temple, John (ECY) <jtem461@ECY.WA.GOV>; Hall, Katie (ECY) <KAWI461@ECY.WA.GOV>; Carlson, Annette (ECY) <anca461@ecy.wa.gov>; Cantu, Jennifer <jcan461@ecy.wa.gov>
Subject: RE: 276-BA Class 1 Prime

DOE agrees with the path forward. Good catch and thank you for the hard work on 276-BA. It's been in my wheel house since 2016, be nice to close it out.

DC

From: Weese, Brigitte (ECY) <bwee461@ECY.WA.GOV>
Sent: Wednesday, August 26, 2020 10:12 AM
To: Martin, Paul W - CHPRC <paul_w_martin@rl.gov>; Carter, Duane B <duane.carter@rl.doe.gov>
Cc: Temple, John (ECY) <jtem461@ECY.WA.GOV>; Hall, Katie (ECY) <KAWI461@ECY.WA.GOV>; Carlson, Annette (ECY) <anca461@ecy.wa.gov>; Cantu, Jennifer <jcan461@ecy.wa.gov>
Subject: 276-BA Class 1 Prime

Paul and Duane,

While working to process the 276-BA Class 1 Prime Modification (PCN-276-BA-2020-01), we realized that Attachment 9 also needs to be edited. The picture below shows "V.32 242-BA Organic Storage Area" in Attachment 9. Although this should say "V.32 276-BA Organic Storage Area", it was a typo that was missed.

Would DOE agree to Ecology making a redline/strikeout revision to the PCN to include the removal of a reference to 276-BA from Attachment 9? Please let us know and we will continue to move forward with this permit modification.

Thank you,

Brigitte Weese
Environmental Specialist
Nuclear Waste Program
(509) 372-7936

mit Production - Home

100%

III.3	Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility						*		
III.4	242-A Evaporator						*		
III.5	325 Hazardous Waste Treatment Units						*		
III.10	Waste Treatment and Immobilization Plant						*		
III.11	Integrated Disposal Facility						*		
III.16	400 Area Waste Management Unit						*		
III.19	Capsule Interim Storage						*		
				Part IV					
IV.	**Unit Specific Conditions for Corrective Action**								
IV.1	100-NR-1				*	*			
				Part V					
V.	**Unit Specific Conditions for Units Undergoing Closure**								
V.6	Waste Encapsulation and Storage Facility Hot Cells A through F					*			
V.25	PUREX Storage Tunnels					*			
V.32	242-BA Organic Storage Area					*			
				Part VI					
VI.	**Unit Specific Conditions for Units in Post Closure**								
VI.1	300 Area Process Trenches							*	

Unit	Permit Revision		Comments/History
	Incorporated	Retired	
300 Area Solvent Evaporator	Rev. 0	Rev. 6	Closed, 7/31/95
300 Area Waste Acid Treatment System	Rev. 6	Rev. 8B	Closed, 1/21/05
303-K Storage Facility	Rev. 4	Rev. 6	Closed, 7/22/02
304 Concretion Facility	Rev. 2	Rev. 6	Closed, 1/21/96
311 Tanks (includes 300 Area WATS)	Rev. 6	Rev. 7	Closed, 5/20/02
3718-F Alkali Metal Treatment/Storage	Rev. 3	Rev. 6	Closed, 8/4/98
4843 Alkali Metal Storage Facility	Rev. 3	Rev. 6	Closed, 4/14/97
Hanford Patrol Academy Demo Site	Rev. 2	Rev. 6	Closed, 11/28/95
Simulated High Level Waste Slurry	Rev. 1	Rev. 6	Closed, 9/6/95
PFP Treatment Unit (HA-20MB)	Rev. 8B	Rev. 8B	Closed, 2/8/05
241-Z Treatment and Storage Tanks	Rev. 8B	Rev. 8B	Closed, 2/22/07
303-M Oxide Facility	Rev. 8B	Rev. 8B	Closed, 6/15/06
224-T Transuranic Waste Storage and Assay Facility	Rev. 8C	Rev. 8C	Closed, 11/12/08
FS-1 Outdoor Container Storage Area Closure	Rev. 8C	Rev.8C	Closed, 10/25/16
Waste Encapsulation and Storage Facility Hot Cells A through F	Rev. 8C		
207-A South Retention Basins	Rev. 8C	Rev. 8C	Closed, 05/18/17
1706 KE Waste Treatment System	Rev. 8C	Rev. 8C	Closed, 1/11/18
600 Area Purgewater Storage and Treatment Facility	Rev. 8C	Rev. 8C	Closed, 02/16/18
PUREX Storage Tunnels	Rev. 8C		Unit group requirements were moved from Part III to Part V Revision 8C (8C.2019.5F, 12/17/18).
276-BA Storage Area	Rev. 8C	Rev. 8C	Closed, 05/18/2020
Part VI, Postclosure Units			
183-H Solar Evaporation Basin	Rev. 4		
300 Area Process Trenches	Rev. 3		

PART III UNIT-SPECIFIC CONDITIONS FOR FINAL STATUS OPERATIONS

Operating Unit 3, Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Operating Unit 4, 242-A Evaporator

Operating Unit 5, 325 Hazardous Waste Treatment Units

Operating Unit 10, Waste Treatment and Immobilization Plant

Operating Unit 11, Integrated Disposal Facility

Operating Unit 16, 400 Area Waste Management Unit

Operating Unit 19, Capsule Interim Storage

PART IV UNIT SPECIFIC CONDITIONS FOR CORRECTIVE ACTION

Corrective Action Unit 1, 100-NR-1

PART V UNIT-SPECIFIC CONDITIONS FOR UNITS UNDERGOING CLOSURE

Closure Unit 6, Waste Encapsulation and Storage Facility Hot Cells A through F

Closure Unit 25, PUREX Storage Tunnels

~~Closure Unit 32, 276-BA Organic Storage Area~~

PART VI UNIT-SPECIFIC CONDITIONS FOR UNITS IN POST-CLOSURE

Post Closure Unit 1, 300 Area Process Trenches

Post Closure Unit 2, 183-H Solar Evaporation Basins

UNITS RETIRED FROM THE PERMIT

100 D Ponds (Closed 8/9/99)

105-DR Large Sodium Fire Facility (Closed 7/1/04)

100-NR-2 Operable Unit (9/30/09)

200 West Area Ash Pit Demolition Site (Closed 11/28/95)

2101-M Pond (Closed 11/28/95)

216-B-3 Expansion Ponds (Closed 7/31/95)

218-E-8 Borrow Pit Demolition Site (Closed 11/28/95)

224-T Transuranic Waste Storage and Assay Facility (Closed 11/12/08)

241-Z Treatment and Storage Tanks (Closed 2/22/07)

2727-S Nonradioactive Dangerous Waste Storage Facility (Closed 7/31/95)

300 Area Solvent Evaporator (Closed 7/31/95)

300 Area Waste Acid Treatment System (Closed 10/30/2005)

303-K Storage Facility (Closed 7/22/02)

303-M Oxide Facility (Closed 6/15/06)

304 Concretion Facility (Closed 1/21/96)

305-B Storage Facility (Closed 7/2/07)

3718-F Alkali Metal Treatment and Storage Facility Closure Plan (Closed 8/4/98)

4843 Alkali Metal Storage Facility Closure Plan (Closed 4/14/97)
Hanford Patrol Academy Demolition Site (Closed 11/28/95)
Plutonium Finishing Plant Treatment Unit (Closed 2/8/05)
Simulated High Level Waste Slurry Treatment and Storage Unit (Closed 10/23/95)
FS-1 Outdoor Container Storage Area (Closed 10/25/2016)
616 Non-Radioactive Dangerous Waste Storage Facility (Closed 9/5/01)
331-C Storage Unit (Closed 7/22/11)
207-A South Retention Basin (Closed 5/18/17)
1324-N Surface Impoundment & 1324-NA Percolation Pond (Closed 4/25/2017)
1706-KE Waste Treatment System Facility (Closed 1/11/18)
600 Area Purgewater Storage and Treatment Facility (Closed 2/16/18)
1301-N Liquid Waste Disposal Facility (Closed 11/28/18)
1325-N Liquid Waste Disposal Facility (Closed 11/28/18)
276-BA Organic Storage Area (Closed 5/18/2020)