OFFICE OF RIVER PROTECTION
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

DEC 17 2015

15-ECD-0060

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Ms. Hedges:

SUBMITTAL OF DANGEROUS WASTE PERMIT DESIGN PACKAGE LAW-016, REV. 0, FOR THE LOW-ACTIVITY WASTE MELTER PROCESS SYSTEM

Reference: WA7890008967, "Dangerous Waste Portion of the Hanford Facility Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Part III, Operating Unit 10, 'Waste Treatment and Immobilization Plant.'"

This letter transmits the Low-Activity Waste (LAW) Facility Dangerous Waste Permit (DWP) Design Package No. LAW-016, Rev. 0, titled *Miscellaneous Treatment Unit Subsystem for LAW Facility LMP System at El. 3 ft.*," (Attachment 1). This permit package provides design information for the LAW Melter Process System, made up of the LAW melters. This action closes out Compliance Schedule Item 23.

Attachment 1 also provides the design information that is necessary for the Washington State Department of Ecology (Ecology) to confirm the structures, systems, and components that are described in the permit package. This will comply with the Reference and will allow Ecology to permit the installation of the two LAW melters.

This permit package submittal is certified coincident with issuance of the integrity assessment report contained in the package. Permit-affecting design changes not included in or occurring after issuance of the final integrity assessment report will be processed in accordance with DWP requirements for permit modifications. The installation of equipment and components will be done in accordance with permit packages that are approved and incorporated into the DWP by Ecology.

Ecology has reviewed the referenced package and comments have been dispositioned.

If you have any questions, please contact me, or your staff may contact Jan B Bovier, Environmental Compliance Division, (509) 376-9630.

Kevin W. Smith
Manager

ECD:JBB

Attachment

cc w/attach:
B.L. Curn, BNI
B.G. Erlandson, BNI
S. Greagor, BNI
M. McCullough, BNI
S.K. Murdock, BNI
D.C. Robertson, BNI
Administrative Record (WTP H-0-8)
BNI Correspondence
Environmental Portal, LMSI

cc w/o attach:
J. Cox, CTUIR
R.S. Skeen, CTUIR
S.L. Dahl, Ecology
D. McDonald, Ecology
G.P. Bohnee, NPT
K. Niles, Oregon Energy
E.D. MacAlister, RL
R. Jim, YN

cc electronic:
J. Cantu, Ecology (2 hard copies)
A.S. Carlson, Ecology (8 hard copies, Public Review)
T.Z. Gao, Ecology
M.E. Jones, Ecology
J.K. Perry, MSA
A.C. McKarns, RL

Attachment 1
15-ECD-0060
(228 Pages)

Dangerous Waste Permit Design Package No. LAW-016, Revision 0
Miscellaneous Treatment Unit Subsystem for LAW Facility LMP
System at El. 3 ft.

Permit Package LAW-016 Description

LAW-016, Rev. 0, "Miscellaneous Treatment Unit Subsystem for LAW Facility LMP System at El. 3 ft"

The Low-Activity Waste (LAW) Facility permit package LAW-016 addresses installation of the two LAW melters at the 3 ft elevation of the LAW Facility.

In the LMP system, LAW melter feed, consisting of LAW waste concentrate mixed with glass former chemicals, is transferred as a slurry by air displacement pumps from the Melter 1 Feed Vessel (LFP-VSL-00002) to LAW melter 1 (LMP-MLTR-00001) through feed nozzles in the melter lid. The process is the same for slurry transferred from the Melter 2 Feed Vessel (LFP-VSL-00004) to LAW melter 2 (LMP-MLTR-00002). In the melter, water and waste feed volatile constituents evaporate, leaving behind a layer of material known as the "cold cap". New slurry is added at about the same rate as the cold cap dissolves in the glass melt pool maintaining the quantity of cold cap material at a steady level. Waste feed components that remain in the cold cap undergo chemical reactions, are converted to their respective oxides, and dissolve in the melt pool. Bubblers inject air into the molten glass for agitation. As the slurry is fed, molten glass is formed that accumulates in the glass tank. When the melt level rises to a predetermined upper limit, an air lift mechanism is actuated and glass is discharged to a container. The evaporated water and waste feed volatile constituents are treated by the primary and secondary offgas treatment systems, monitored, and released to the atmosphere.

Permit package LAW-016, Rev. 0, includes:

- An assessment report signed by an independent qualified registered professional engineer (IQRPE) certifying certain portions of the permit package
- Melter assembly mechanical drawings
- An engineering specification for the LAW melters
- A specification change notice – update seismic clamp installation
- A mechanical data sheet for each LAW melter
- A corrosion evaluation for the LAW melters

The following components of this package are already included in the Dangerous Waste Permit and in the Administrative Record, or they are provided with other permit packages, as listed in the Table of Contents:

- A general arrangement plan for the 3-ft elevation of the LAW Facility
- Two process flow diagrams for the LMP system
- Twenty-seven piping and instrumentation diagrams
- Engineering specifications for:
  - Pressure vessel design and fabrication
  - Seismic qualification criteria for pressure vessels
  - Pressure vessel fatigue analysis
  - Positive material identification for shop fabrication
- A document describing secondary containment design
- A document describing the LAW offgas system bypass analysis
- A document describing the installation of tank systems and miscellaneous treatment unit systems
- A system design description for the LAW melter
- A material and energy balance (Flowsheet Bases and Assumptions)
- A document describing the control of toxic vapors and emissions from WTP tank systems and miscellaneous treatment unit systems
- A document describing the control of hydrogen accumulation in tank systems and miscellaneous treatment unit systems

Permit Design Package No. LAW-016, Rev 0

CCN280026

Miscellaneous Treatment Unit Subsystem for LAW Facility LMP System at El. 3 ft

Table of Contents

December 11, 2015

For Incorporation into the Permit

Engineering Document Title	Document Number	Revision	Permit Condition	Included	Remarks
IQRPE Independent Assessment Report	24590-CM-HC4-HXYG-00240-02-00014		III.10.H.5.c.i	Y	To be included in Appendix 9.11
Permit Package Drawings					
General Arrangement Plans	24590-LAW-P1-P01T-00002	7	III.10.H.5.c.ii	N	In Appendix 9.4
Process Flow Diagrams	24590-LAW-M5-V17T-00004	4	III.10.H.5.c.ii	N	In Appendix 9.1
	24590-LAW-M5-V17T-00005	4			
Piping and Instrument Diagrams	24590-LAW-M6-LMP-00001001 CBI	0	III.10.H.5.c.ii	N	In Appendix 9.2
	24590-LAW-M6-LMP-00002001 CBI, 00002002 CBI	0			
	24590-LAW-M6-LMP-00003001	0			
	24590-LAW-M6-LMP-00040001	0			
	24590-LAW-M6-LMP-00005001 CBI	0			
	24590-LAW-M6-LMP-00007001, 00007002	0			
	24590-LAW-M6-LMP-00008001	0			
	24590-LAW-M6-LMP-00010001	0			
	24590-LAW-M6-LMP-00012001	0			
	24590-LAW-M6-LMP-00031001 CBI	0			
	24590-LAW-M6-LMP-00032001 CBI, 00032002 CBI	0			
	24590-LAW-M6-LMP-00033001	0			
	24590-LAW-M6-LMP-00035001 CBI	0			

For Incorporation into the Permit

Engineering Document Title	Document Number	Revision	Permit Condition	Included	Remarks
	24590-LAW-M6-LMP-00037001, 00037002	0			
	24590-LAW-M6-LMP-00038001	0			
	24590-LAW-M6-LMP-00042001	0			
	24590-LAW-M6-LMP-00013001, 00013002, 00043001	0			
	24590-LAW-M6-LOP-00004001, 00004002	0			
	24590-LAW-M6-LOP-00005001, 00005002	0			
Mechanical Drawing					
LAW Melter Assembly - Isometric View	24590-LAW-MF-LMP-00001	0	III.10.H.5.c.ii III.10.H.5.c.vi	Y	To be included in Appendix 9.6
LAW Melter Assembly - Plan View	24590-LAW-MF-LMP-00002	0		Y	To be included in Appendix 9.6
LAW Melter Assembly – East, West and North Elevation	24590-LAW-MF-LMP-00003	0		Y	To be included in Appendix 9.6
LAW Melter Assembly – Section A-A	24590-LAW-MF-LMP-00004	0		Y	To be included in Appendix 9.6
Engineering Specifications:					
Pressure Vessel Design and Fabrication	24590-WTP-3PS-MV00-T0001	5	III.10.H.5.c.ii III.10.H.5.c.iii III.10.H.5.c.vi	N	In Appendix 7.7. Rev 5 is going in LAW-025
Seismic Qualification Criteria for Pressure Vessels	24590-WTP-3PS-MV00-T0002	3		N	In Appendix 7.7
Pressure Vessel Fatigue Analysis	24590-WTP-3PS-MV00-T0003	3		N	In Appendix 7.7
Positive Material Identification (PMI) for Shop Fabrication	24590-WTP-3PS-G000-T0002	9		N	In Appendix 7.7. Rev 9 is going in LAW-028
Low Activity Waste Melters	24590-LAW-3PS-AE00-T0001	6		Y	To be included in Appendix 9.7
Specification Change Notice - Update Seismic Clamp Installation	24590-LAW-3PN-LMP-00002	N/A		Y	To be included in Appendix 9.7
Mechanical Data Sheets:					
Low-Activity Waste Melter 1	24590-LAW-M0D-LMP-00001	3	III.10.H.5.c.ii III.10.H.5.c.vi	Y	To be included in Appendix 9.6
Low-Activity Waste Melter 2	24590-LAW-M0D-LMP-00002	3		Y	To be included in Appendix 9.6

Permit Design Package No. LAW-016, Rev 0
Miscellaneous Treatment Unit Subsystem for LAW Facility LMP System at El. 3 ft
Table of Contents

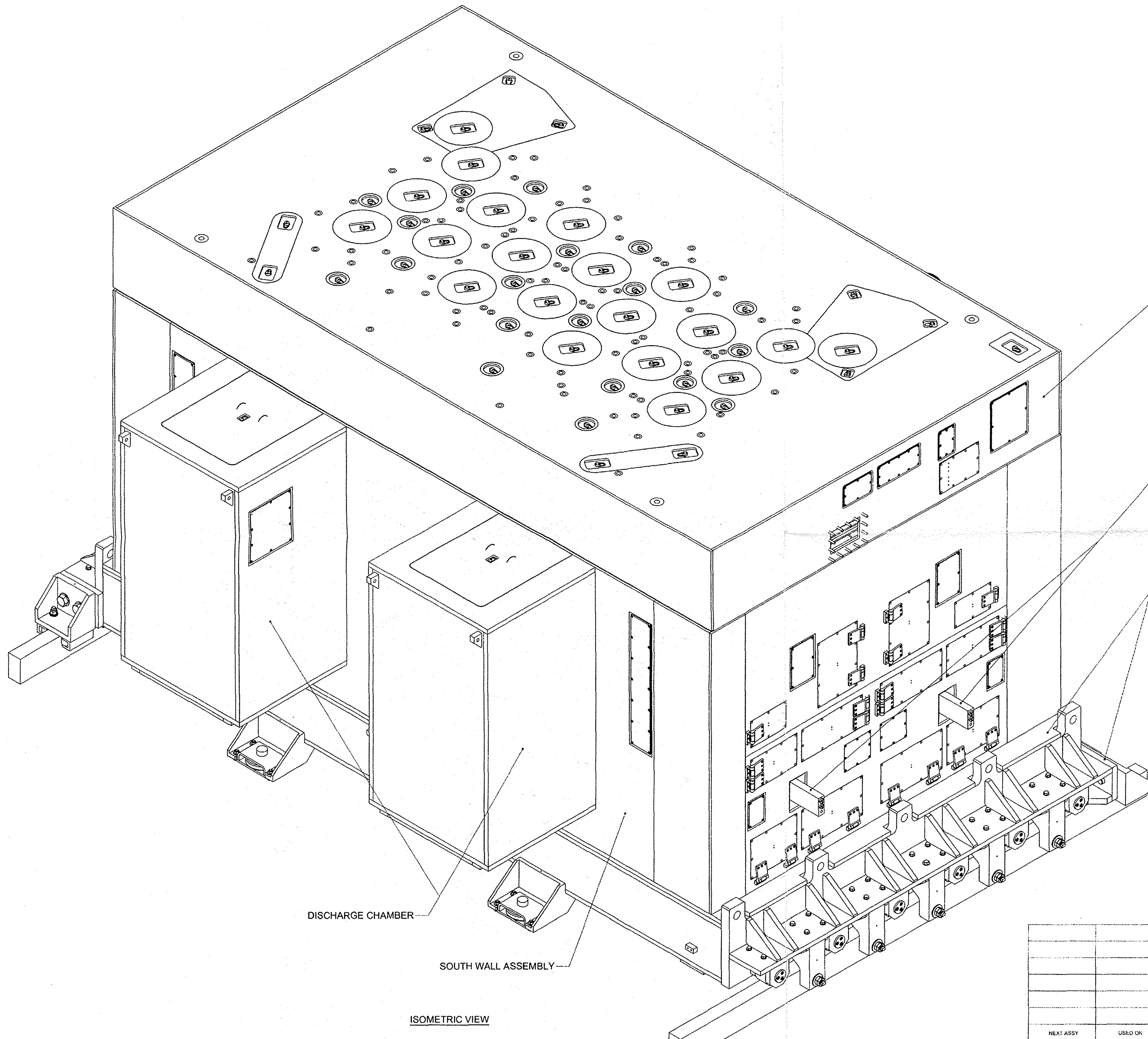
For Incorporation into the Permit

Permit Design Package No. LAW-016, Rev 0
Miscellaneous Treatment Unit Subsystem for LAW Facility LMP System at El. 3 ft
Table of Contents

For Incorporation into the Administrative Record

Engineering Document Title	Document Number	Revision	Permit Condition	Included	Remarks
Structural Support Calculations Specific to Off-Specification, Non-Standard and Field Fabricated Subsystems	Not Applicable	-	III.10.H.5.c.iii	N	There are no off-specification, non-standard and field fabricated subsystems in the LAW facility El. +3 ft
Low-Activity Waste Melter Process System Design Description	24590-LAW-3ZD-LMP-00001	0	III.10.H.5.c.vii	Y	For incorporation into Administrative Record
Flowsheet Bases, Assumptions, and Requirements	24590-WTP-RPT-PT-02-005	7	III.10.H.5.c.viii	N	In Administrative Record (CCN 282694)
2010 WTP Material Balance and Steady State Flowsheet Assessment, Deliverable 2.7	24590-WTP-RPT-PET-10-022	0	III.10.H.5.c.viii	N	In Administrative Record (CCN 241137)
Steady-State (AES) Model Run Report for 2010 Material Balance and Process Flowsheet Analysis Assessment Report	24590-WTP-MRR-PET-10-010	0	III.10.H.5.c.viii	N	In Administrative Record (CCN 241137)
Control of Toxic Vapors and Emissions from WTP Tank Systems and Miscellaneous Treatment Unit Systems	24590-WTP-PER-PR-03-002	3	III.10.H.5.c.xi	N	In Administrative Record (CCN 178564)
Prevention of Hydrogen Accumulation	LAW Miscellaneous Treatment Unit Hydrogen Accumulation Document for the DWP Administrative Record (CCN 280210)	N/A	III.10.H.5.c.xii	N	Incorporate into Administrative Record. Submitted with LAW-025.

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 MATERIAL AT DOE-OWNED NUCLEAR FACILITIES. INFORMATION CONTAINED HEREIN ON RADIONUCLIDES IS PROVIDED FOR PROCESS DESCRIPTION PURPOSES ONLY.



ISOMETRIC VIEW

CONTENTS OF THIS DOCUMENT ARE DANGEROUS WASTE PERMIT AFFECTING

REFERENCE DRAWINGS	
24590-QL-HC4-W000-00011-03-00523	MELTER ASSEMBLY SHIELDED LID

Q

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ISSUE STAMP

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

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REVIEWER	[signature]	3-15-11
APPROVER	[signature]	3-16-11

CONTENT APPLICABLE TO ALARA? YES [X] NO [ ]
ADR NO 24590-LAW-ADR-ML-05-0001 REV: 0
SAFETY SCREEN REQUIRED? YES [ ] NO [X] E&NS INITIAL IF YES N/A

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

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LAW MELTER ASSEMBLY LAW-MLTR-00001/00002 ISOMETRIC VIEW

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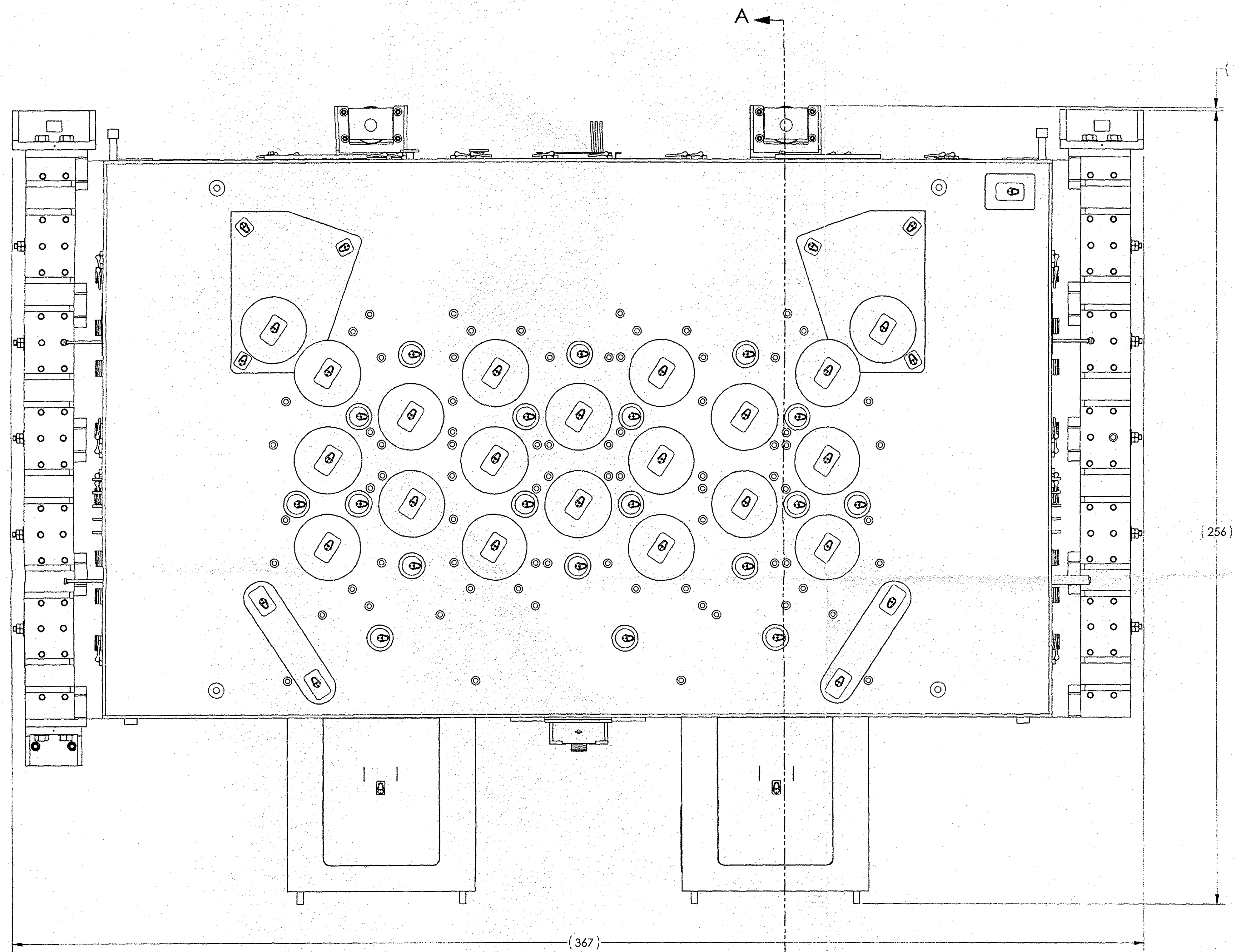

PLAN VIEW
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REFERENCE DRAWINGS

DRAWING NUMBER	TITLE
24590-QL-HC4-W000-00011-03-00516	MELTER ASSEMBLY START-UP/OPERATION

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AREA	200E
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REVIEWER	[signature]	3-15-11
APPROVER	[signature]	3.16.11

CONTENT APPLICABLE TO ALARA? YES [X] NO [ ]
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SAFETY SCREEN REQUIRED? YES [ ] NO [X] E&NS INITIAL IF YES N/A

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LAW MELTER ASSEMBLY LAW-MLTR-00001/00002 PLAN VIEW

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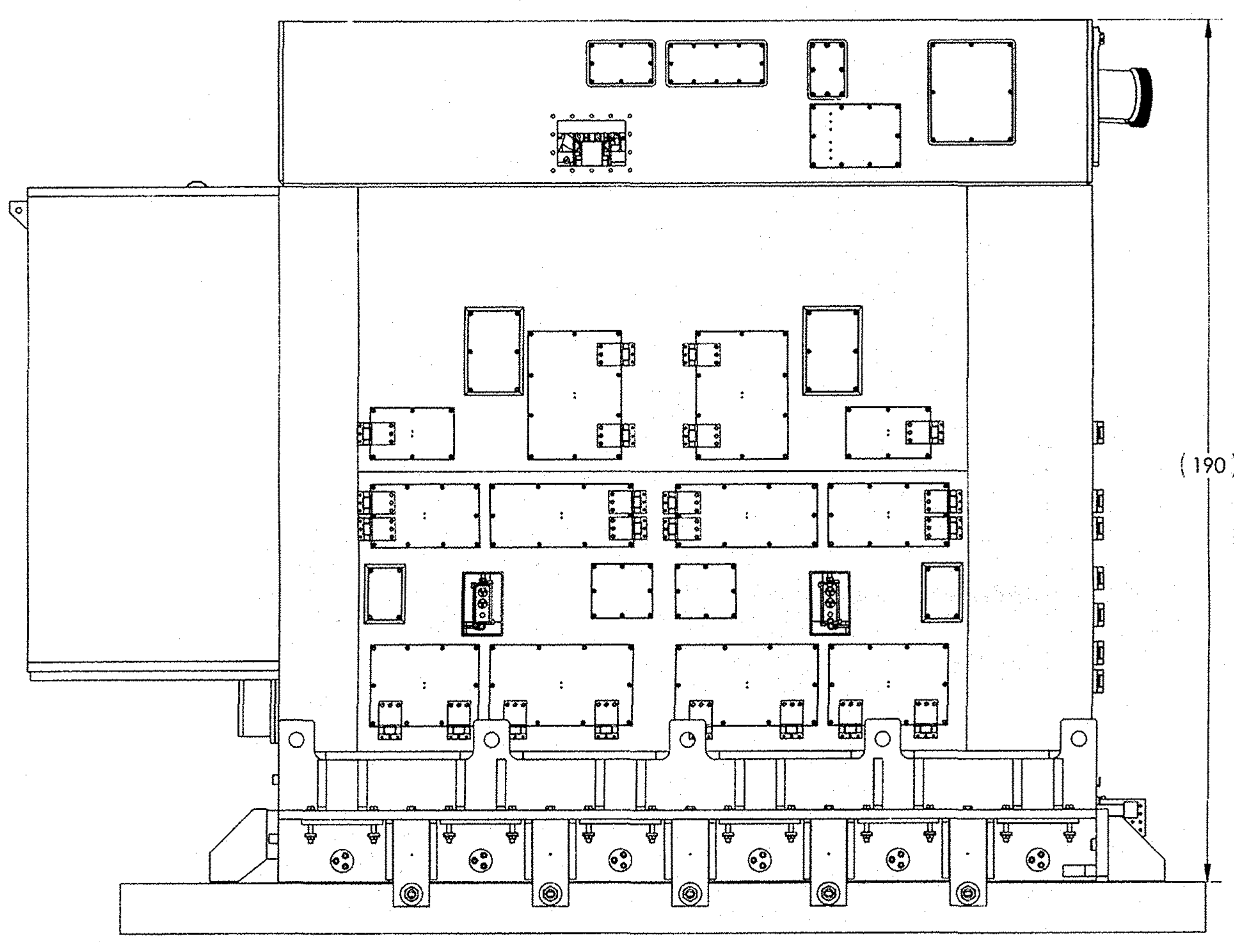

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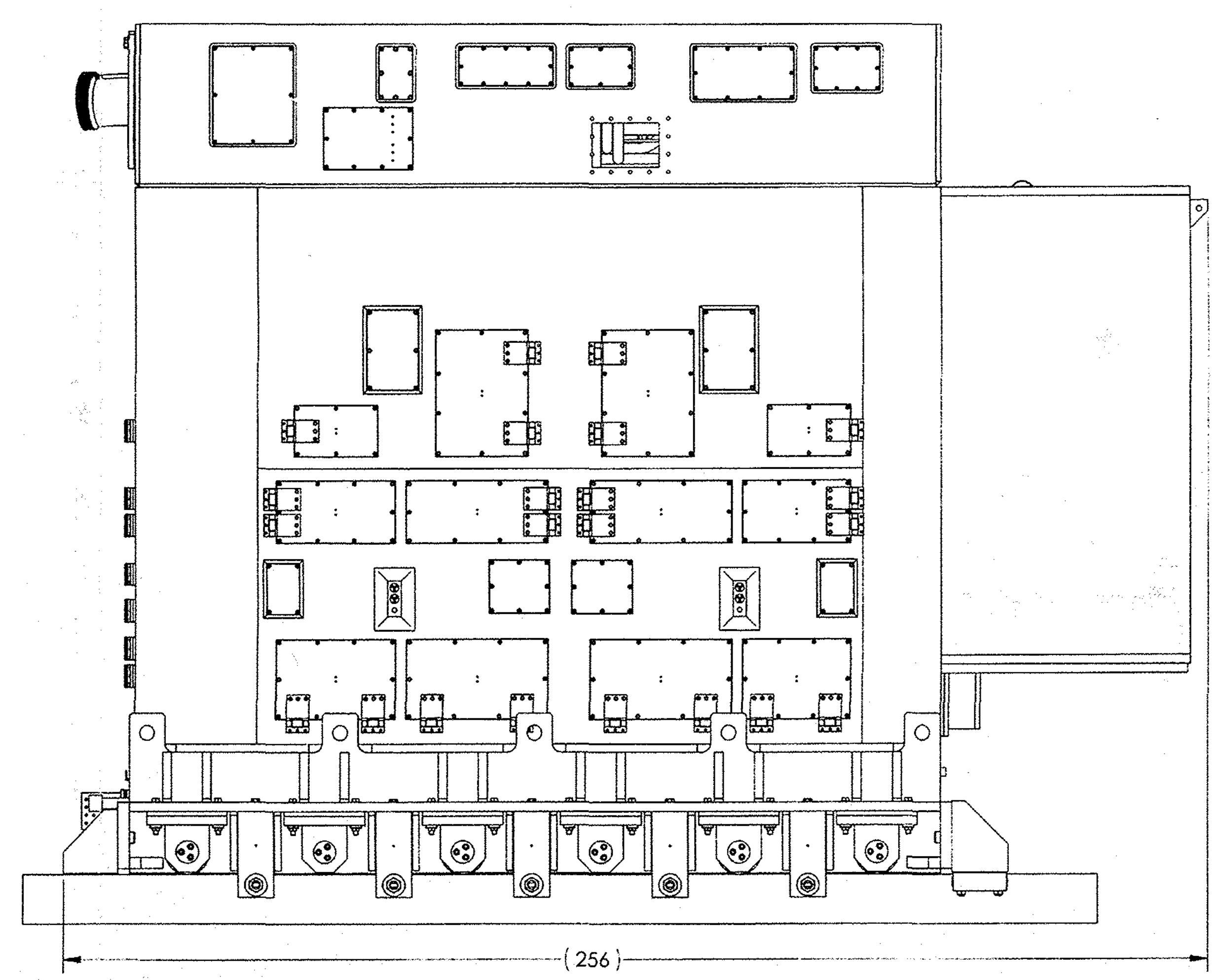

EAST ELEVATION
SCALE 1:25

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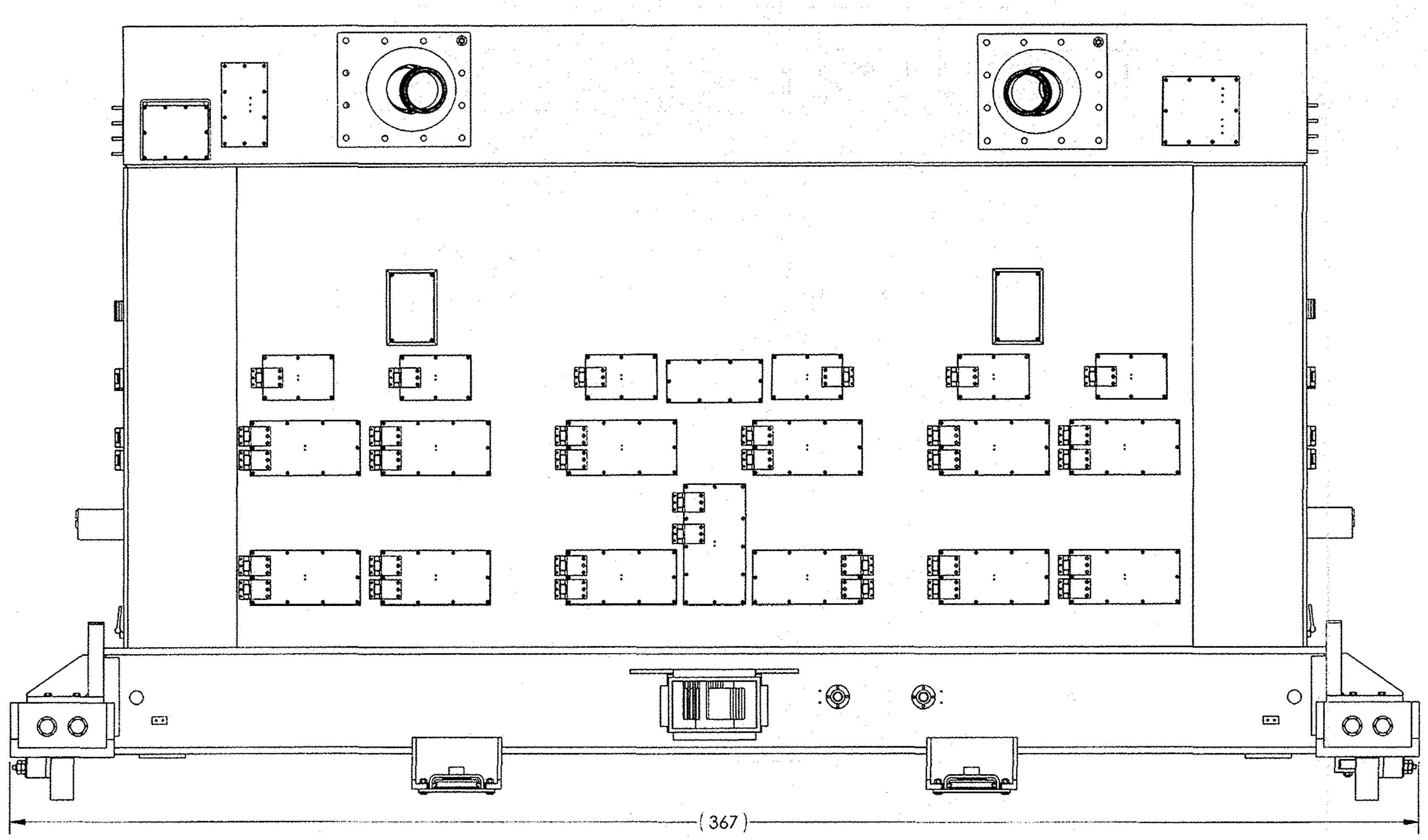

NORTH ELEVATION
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REFERENCE DRAWINGS

DRAWING NUMBER	TITLE
24590-QL-HC4-W000-00011-03-00516	MELTER ASSEMBLY START-UP/OPERATION

REVISION HISTORY

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PROJECT No.	24590
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REVIEWER	(signature)	3-15-11
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CONTENT APPLICABLE TO ALARA? YES [X] NO [ ]
ADR NO 24590-LAW-ADR-ML-05-0001 REV: 0
SAFETY SCREEN REQUIRED? YES [ ] NO [X] E&NS INITIAL IF YES N/A

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LAW MELTER ASSEMBLY
LAW-MLTR-00001/00002
EAST, WEST AND NORTH ELEVATION

SCALE: AS SHOWN

24590-LAW-MF-LMP-00003

REV 0

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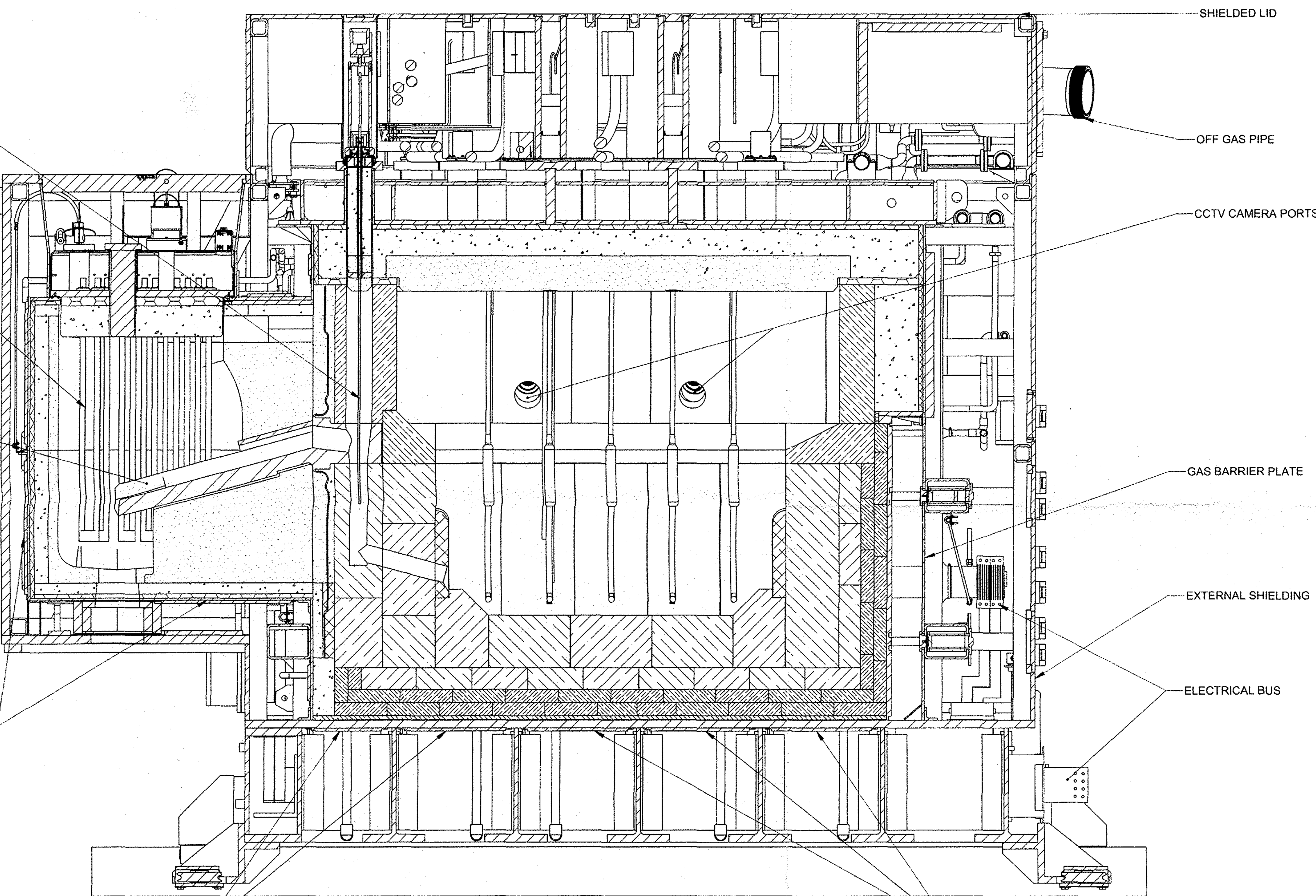

SECTION A-A
SEE DWG 24590-LAW-MF-LMP-00002
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REFERENCE DRAWINGS

DRAWING NUMBER	TITLE
24590-QL-HC4-W000-00011-03-00518	MELTER ASSEMBLY START-UP/OPERATION

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REVISION HISTORY

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PROJECT No.	24590
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BUILDING No.	20

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RIVER PROTECTION PROJECT
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RICHLAND, WA 99354

CONTRACT No: DE-AC27-01RV14136

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CONTENT APPLICABLE TO ALARA? YES [X] NO [ ]
ADR NO 24590-LAW-ADR-ML-05-0001 REV: 0
SAFETY SCREEN REQUIRED? YES [ ] NO [X] E&NS INITIAL IF YES N/A

LAW MELTER ASSEMBLY
LAW-MLTR-00001/00002
SECTION A-A

SCALE: AS SHOWN
24590-LAW-MF-LMP-00004
REV 0

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INIT DATE

RIVER PROTECTION PROJECT – WASTE TREATMENT PLANT

ENGINEERING SPECIFICATION

FOR

Low Activity Waste Melters

Content applicable to ALARA? ☒ Yes ☐ No

ADR No. 24590-LAW-ADR-ML-05-0001 **Rev** 1

Specification changes retroactive? ☐ Yes ☒ No ☐ N/A (alpha revision or revision 0)

Note: Contents of this document are Dangerous Waste Permit affecting.

Quality Level
Q
DOE Contract No. DE-AC27-01RV14136

REV	DATE	BY	CHECK	AUTHORIZATION	AUTHORIZATION	APPROVER
6	5/1/15	Originator By: Rich Peters - rpeters1 Org Name: LAW Melter Lead Placed: Apr 14, 2015, 11:20 am	Checked By: Matt Meyer - mfmeyer1 Org Name: LAW - Mechanical Systems Placed: Apr 16, 2015, 2:56 pm	N/A	N/A	~~S. Kretzschmar Sr.~~ P. RAJAGOPALAN 5/1/15
5	12-6-09	L. Curtis	R. Figley	N/A	N/A	T. Hughes
0	11-2-01	K. Clarke	L. Donovan	N/A	N/A	C. Winkler

SPECIFICATION No.	Rev
24590-LAW-3PS-AE00-T0001	6

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 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.

Revision History

Revision	Reason for Revision	Q Specification Revision Only Margin Reduced?		CM Only
		YES	NO	N/A
A		N/A	N/A	N/A
0	Initial Issue - Supercedes SP0W375LV-M00001, Rev D	☐	☒	☐
1	Reissued with technical requirement changes and clarifications	☐	☒	☐
2	Reissued with general editing, minor requirement changes to reflect current design, and design interface details	☐	☒	☐
3	Reissued to update references in Section 2, incorporate SCNs 24590-LAW-3PN-AE00-00001, 24590-LAW-3PN-AE00-00002 and 24590-LAW-3PN-AE00-00003, and update Appendices A and B to reflect P&IDs.	☐	☒	☐
4	Reissued to incorporate 24590-LAW-3PN-AE00-00004, 24590-LAW-3PN-AE00-00005, 24590-LAW-3PN-AE00-00006, 24590-LAW-3PN-AE00-00007, and 24590-WTP-SDDR-ML-07-00117. Appendix A: Added Celsius temperatures and removed part number from connection style.	☐	☒	☐
5	Updated to align with the Basis of Design, Section 1.2: Edited/added definitions.	☐	☒	☐
6	Updated to align with current project specifications and state of the design. Clarified wording at the front of Appendices. Incorporates 24590-LAW-3PN-AE00-00009. Complete revision, change bars not required.	☐	☒	☐

Contents

Appendices

1 General

1.1 Scope

A This Specification provides performance requirements for the design of Low Activity Waste (LAW) vitrification melters for the River Protection Project - Waste Treatment Plant (RPP-WTP) at the Hanford, Washington Site of the Department of Energy (DOE).

B Deleted.

C The melters include, but are not limited to, the following major structures, systems and components (SSCs): glass containment, radiation shielding, glass and glass discharge heating, refractory cooling, radiation shield cooling, instrumentation, offgas cooling and collection, waste and glass feed, glass frit addition for startup, agitation, and glass discharge.

D Deleted.

E Not Used.

F The unit tested during the LAW pilot melter program (see description in Ref 2.2Q) provides the technological basis for the LAW melter design.

1.2 Definitions

A Annular Space – In the melter and the discharge chambers, the void space between enclosure and gas barrier walls. Does not include the void space within the melter lid itself.

B Base – Structural platform that supports the melter during transport and operation. Base includes structural steel and bracing, and cooling water panel structures. Base also includes plates that provide a portion of the gas barrier. The base has transport and restraint interface points.

C Contractor – Bechtel National, Inc.

D Design Life – The baseline time, based on calculation, analysis, experience or testing, over which the SSC will safely maintain its original function.

E Enclosure – Consists of the outermost steel plate of the containment system that includes the walls, lid covers of the melter and discharge chamber lids, and removable panels for accessing melter components. The enclosure also includes the lid portion of the structural bracing and guide tubes for components penetrating the melter lid. The enclosure serves as radiation shielding and structurally supports the shell function to provide bulk confinement of glass and offgas.

F Transportation System -- Melter components that aid in the transport and positioning of the melter during transportation, installation and operation, decommissioning, and disposal.

G Lid – Structural cover over the top of the melter plenum space that supports lid plenum refractory and all components mounted through it. Lid also includes plates that provide a portion of the gas barrier.

H Normal Operation – Constitutes all regular and scheduled melter activities geared towards production of glass product at or near design throughput, i.e., feeding, pouring, idling, and scheduled SSC change-out.

I Structure – Melter and discharge chamber structural steel, including bracing that support the gas barrier walls, wall cooling water panel structures and enclosure. Melter structure also supports the melter lid.

J Subcontractor – Duratek, Inc. Note: BNI and EnergySolutions continue to support design modifications after the melter design was initially provided by Duratek (bought out by EnergySolutions).

K Vendor – A manufacturer or supplier providing materials and/or services to the subcontractor.

L Gas Barrier – Comprised of the internal surfaces of the melter walls, lid and base, supporting the offgas-related functions of the shell.

M Frit – Glass particulate of a size and geometry suitable for direct feed into the melter.

N Shell - System of structural elements that performs the credited safety functions of the melter shell. These are to provide a bulk confinement boundary for both the glass and offgas and to direct the offgas into the melter offgas system when the melter is operating. The shell is comprised of the base, external walls, lid, and lid covers, (gas barrier plates) which are to be structurally supported by the enclosure.

O Walls - The vertical plate assemblages that support the lid and lid portion of the enclosure. The exterior surfaces form part of the enclosure, the interior surfaces form part of the gas barrier.

P Containment System - The containment system provides bulk confinement of glass during normal and abnormal conditions. The containment system includes the melter shell, refractory, cooling panels, and jackbolts. Of these components, the shell is quality level Q and the refractory, cooling panels, and jackbolts are quality level CM.

1.3 Acronyms

CCTV	Closed Circuit Television
DOE	Department of Energy
ICD	Interface Control Document
LAW	Low Activity Waste
SC	Seismic Category
SSC	Systems, Structures, and Components
RPP-WTP	River Protection Project - Waste Treatment Plant
w.g.	Water Gage (pressure measurement)

2 Applicable Documents

2.1 Referenced Codes and Industry Standards

Unless otherwise noted, all codes and standards referenced herein, and in the documents referenced in Section 2.2, shall be to the latest editions, addenda, and supplements at the time of award.

A Not Used.

B American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

1 IEEE Std 141, *Recommended Practice for Electric Power Distribution for Industrial Plants* (1986)

2 IEEE Std 260.1, *American National Standard Letter Symbols for Units of Measurement* (1993)

3 IEEE Std 315, *Graphic Symbols for Electrical and Electronics Diagrams* (reaffirmed 1993)

4 IEEE Std 399, *Recommended Practice for Industrial and Commercial Power Systems Analysis* (1997)

5 IEEE Std 1202, *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies* (1991)

6 IEEE Std 384, *Standard Criteria for Independence Class 1E Equipment and Circuits, Table 2 "Enclosed to open Configuration"*, (1992)

C American Society of Civil Engineers (ASCE)— ASCE-7, *Minimum Design Loads in Building and Other Structures* (1998)

D American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

1 ASME B31.3, *Process Piping, Normal Service* (1996)

2 Not Used.

3 ASME Section VIII, Division 1, *Rules for Construction of Pressure Vessels*, 2001 Edition, (2002 Addenda)

4 ASME NQA-1, *Quality Assurance Requirements for Nuclear Facility Facilities* (1989)

5 Deleted.

6 ASME Section VIII, Division 2, *Rules for Construction of Pressure Vessels*, 2001 Edition, 2002 Addenda)

7 ASME, Section VIII. 2001. *Boiler and Pressure Vessel Code.*

8 ANSI/AISC N690-1994, Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities.

E Code of Federal Regulations (CFR)

1 29 CFR 1910, Subpart D, *Occupational Safety and Health Administration, 1970, Walking – Working Surfaces* (most current revision)

2 29 CFR 1910, Subpart S, *Occupational Safety and Health Administration, 1970, Electrical* (most current revision)

F International Conference of Building Officials (ICBO)— *Uniform Building Code* (UBC), (1997)

G National Electrical Manufacturers Association (NEMA)

1 NEMA WC, *Wire and Cable Standards* (1999)

2 NEMA/ICEA (Insulated Cable Engineers Association), *Power Cable Ampacities* (1999)

H National Fire Protection Association (NFPA)

1 NFPA 70, *National Electrical Code* (1999)

2 NFPA 497, *Recommended Practice for Classification of Hazardous Locations for Electrical Installations in Chemical Process Areas* (1997)

I Underwriters Laboratories Inc. (UL)— UL 508, *Standard for Safety Electrical Industrial Control Equipment* (1999)

J American Institute of Steel Construction (AISC) - AISC M016-89, Manual of Steel Construction - Allowable Stress Design, Ninth Edition

K American Welding Society (AWS)

1. AWS D1.1:2000, Structural Welding Code – Steel
2. AWS D1.6: 1999, Structural Welding Code – Stainless Steel

2.2 Other Reference Documents/Drawings

References listed below show revisions in effect at the time melter design was completed. Review of subsequent revisions indicate no impact to the LAW melter design.

A Not Used.

B Document No. 24590-WTP-3PS-J000-T0001, Rev 1, *Engineering Specification for Melter Systems C&I Work Specification*

C Not Used.

D Not Used.

E Deleted.

F Document No. 24590-WTP-DC-ST-01-001, Rev 13, *Structural Design Criteria*

G Document No.24590-WTP-DC-PS-01-001, Rev 8, *Pipe Stress Design Criteria*

H Document No. 24590-WTP-DC-ST-04-001, Rev 4A, *Seismic Analysis and Design Criteria*

I Document No. 24590-WTP-3PS-FB01-T0001, Rev 6. *Engineering Specification for Structural Design Loads for Seismic Category III and IV Equipment and Tanks*

J 24590-WTP-PSAR-ESH-01-002-03, Rev 05H, Preliminary Documented Safety Analysis to Support Construction Authorization; LAW Facility Specific Information.

K 24590-LAW-M0Q-LMP-00003, Rev 0, Equipment Qualification Datasheet for Low Activity Waste (LAW) Melters

L 24590-WTP-RPT-OP-01-001, Rev 4, Operations Requirements Document

M 24590-WTP-3PS-MQR0-T0004, Rev 1, ENGINEERING SPECIFICATION FOR LAW FACILITY MELTER RAILS

N 24590-101-TSA-W000-0010-409-1137, Rev 00A, LAW MELTER LIFE REPORT

O 24590-WTP-3PS-MEEM-T0001, Rev 0, ENGINEERING SPECIFICATION FOR MELTER START-UP FRIT

P 24590-101-TSA-W000-0009-172-00001, Rev 00A, FINAL REPORT - REVIEW OF PROPERTIES OF SIMULATED FEEDS USED FOR MELTER TESTING

Q 24590-QL-HC4-W000-00094-03-00020, Rev 00A, RPP-WTP LAW PILOT MELTER DISASSEMBLY REPORT

R 24590-LAW-N1D-LMP-00001, Rev 0., LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels

3 Design Requirements

The body of this specification identifies the functional design requirements for the LAW melter. Appendices A and B, "Melter Services and Connections Interface Details" and "Melter Design Interface Details" respectively, provide requirements and interfaces that were used in the initial development of the melter design.

3.1 General Functional Requirements

A Deleted.

B Containment System: The containment shall incorporate the following design features.

1 Enclosure: Design shall incorporate the following:

a Penetrations and removable panels to facilitate removal and replacement of consumable melter components. Provide guide tubes around penetrations (through to the melter) and coordinate with contractor to optimize in-leakage to the annular space.

b Means to prevent leakage of offgas into the surrounding melter gallery, and be glass-tight up to the maximum operating level of glass in the melter.

c External surfaces configured to limit contamination buildup.

d Routing and containment of feed and service lines, both radioactive and nonradioactive.

e Ability to contain the full melter volume of spilled glass.

f Lid portion of the enclosure shall be strong enough to prevent loss of confinement or operational integrity in the event of dropped loads as specified in section 3.5.D.2.b.

2 Jack bolts: Design jack bolt system to prevent formation of significant gaps between refractory bricks during startup and operation. Bolt self-adjustment shall allow for:

a Compression of refractory during melter assembly and installation.

b Adjustment of the compressive force on the refractory to correct for uneven movement.

c Re-compression of refractory.

3 Melter Lid: Design shall include, but not be limited to, the following functions:

a Support all melter components mounted on and through it.

b Support refractory overhanging melter plenum, and allow thermal expansion of refractory during operation.

c Provide a continuous gas barrier in conjunction with wall and base gas barrier plates.

d Provide refractory and lid surface cooling through the incorporation of a cooling cavity.

e The lid cooling cavity shall confine the cooling water to prevent it from entering the melter plenum and shall ensure adequate cooling of the of the inconel plate that forms the top of the Gas Barrier.

f The water inlet and outlet penetrations into and out of the Melter Lid Cooling Cavity shall be elevated near the top of the cavity to limit the loss of water mass should a leak develop in the cooling water circuit (Ref 2.2J).

g The melter lid design shall allow for placement of four (4 Ea.) resistance temperature detectors (RTDs), two (2Ea.) of which will be considered Safety Significant (SS) as they will be supporting the credited safety function of monitoring the melter lid cooling cavity temperatures as defined 2.2J. The placement of the RTDs and cabling shall be per ref. 2.1B6.

h The melter lid design shall allow for periodic replacement of the RTDs.

4 Not Used.

5 Melter Base: Base will perform the following functions:

a Support melter during transport, operation and maintenance, decommissioning and disposal phases.

b Accommodate integrated transportation system.

c Provide structurally sound interfaces with facility and seismic transporter restraints.

d Provide refractory cooling.

e Provide support for refractory during melter assembly, transport, installation, and operation.

f House melter services including drains, refractory cooling panels and electrode bus connectors.

g Provide flatness tolerances for refractory installation.

6 Shell: The design of the elements of the melter Shell shall meet the following requirements:

a. The shell must remain intact when exposed to its environmental and operating loadings.

b. The shell must be designed to withstand the effects of maximum credible offgas exhauster suction at the melter and pressurization upsets. (see 3.5D4a)

c. The shell shall function as the offgas and glass confinement boundary.

C Heating System

1 Heating system includes the electrodes (including extensions), electrode buses, power supplies, startup heaters, discharge chamber heaters, and thermocouples.

2 After initial melter heating with startup heaters, glass is direct joule-heated.

3 Thermocouples shall be designed to provide continuous temperature monitoring while the melter is in service.

D Feed System

1 Feed system includes temporary configuration for frit addition at startup, feed nozzles and associated feed lines (internal to shielding only) for operation, and plenum thermocouples.

2 Subcontractor shall use the best available information for locating feed nozzles over the glass pool to optimize processing rates.

E Glass Pour System

1 Glass pour system includes glass pool level detectors, risers and airlift lances, troughs, dams, and discharge chamber structures.

2 Metallic Membrane (dam): Dam between the glass pool and discharge chamber is designed to prevent leakage of glass from the melt pool to the discharge chamber. Dam shall also limit leakage of air directly into the melter plenum through refractory seams over the melter lifetime.

3 Discharge Trough: Optimize trough slope and cross section for pouring and reduction of glass fiber formation.

F Agitation System

1 Bubblers provide agitation.

2 Arrangement and configuration of bubblers is for achieving optimized throughput while limiting refractory wear.

3 Each bubbler assembly, in coordination with the contractor, shall be designed for individual removal and replacement.

G Melter Disposal and Decommissioning: Specific design requirements for melter disposal and decommissioning are not defined.

H Melter Controls and Instrumentation: See Ref 2.2B for specific melter-related functional requirements for controls and instrumentation.

I Transportation System:

1 Support roller/wheel bogies for melter transport on facility rails.

2 Guide and position melters on facility rails.

3 Deleted

4 Provide interfaces with contractor-supplied drive systems that conform to subcontractor-defined melter movement tolerances for import and export of melter.

5 Deleted

J General Melter Component Design

1 Components requiring replacement during the design life of the melter shall be designed for ease of replacement and disposal. Where required, provide installed spare capacity.

2 Use of commercially available components and equipment, without modifications, will be optimized to the extent possible, except for components requiring optimization/value engineering studies per the contract.

3 Subcontractor shall coordinate with contractor to determine applicability of modular design to minimize assembly and replacement times.

4 Modular components and equipment requiring removal and replacement during startup and operation shall not weigh more than the safe working load of the largest overhead maintenance crane (10 tons).

5 Conductive individual components and equipment in contact with molten glass shall be electrically isolated from the melter structure, base, lid, enclosure, and from SSCs physically connecting the melter to the rest of the facility.

6 All components shall be designed to withstand thermal expansion during normal operations and function within established design parameters (such as, interface locations and positioning features).

7 Components and/or utility and service connections specified by the subcontractor that protrude from the enclosure shall be subject to review and approval by the contractor.

8 Design of the melter must prevent accumulation of water between the cooling panels and the melter shell or refractory. No sealed cavities shall exist between the cooling panels and the melter shell or refractory.

9 A water-sulfate steam explosion could cause a modest localized pressure pulse within the melter. The melter, including the feed nozzle cooling jacket components below the melter lid, will maintain its confinement boundary following a steam explosion from a water sulfate layer interaction.

K Restraint System

1 Melter assembly shall be restrained to prevent motion during a seismic event.

2 In coordination with the contractor, subcontractor shall be responsible for the design of the restraint components integral to or attached to the melter structure, including clamps and brackets interfacing with the facility rail system.

3.2 Performance Requirements

A Design Life

1 The facility is expected to operate for approximately 40 years.

2 The melters, excluding consumable SSCs specified by the subcontractor, shall have a minimum 5-year design life.

3 Design life of subcomponents shall be per Ref 2.2 N.

4 Not Used.

5 Deleted.

B Melter Throughput and Availability

1 Baseline throughput shall be 15 metric tons of glass per day, per melter. This is based on the conditions in section B 2.

2 Melter shall transform a slurry mixture of pretreated low activity waste and blended glass formers into a homogeneous glass melt. The glass and feed properties are as follows:

Glass properties: conductivity = 0.1 S/cm @ 1100 C to 0.7 S/cm @ 1200 C; viscosity = 10 to 150 Poise @ 1100 C with 30 to 50 Poise @ 1150 C optimal.

Glass melt pool operating temperature: 1100 to 1200 C with set point at 1150 C

Glass start-up frit: In accordance with Ref 2.2 O.

Feed Properties: Refer to 2.2 P

3 Target baseline availability for the melters is 83% (working number – will be confirmed when the operational research model is released). Subcontractor shall interface with contractor to ensure that melter design supports goal.

3.3 Design Conditions

A Deleted

B Facility Data

1 Guidance for melter and subcomponent dimensional envelope allowances are shown in Appendix B. Note that this data was used as the initial interface between the melter and the facility (see note at front of Appendix B).

2 Melter Ventilation:

a Melter will be operated as part of a cascaded ventilation system.

b Melter gallery will be a tertiary confinement zone, held at a nominal 0.4-in. w.g. negative pressure with respect to surrounding facility confinement zones.

c Contractor will provide melter annular space ventilation and exhaust. The melter annular space will be held at a nominal 2-in. w.g. negative pressure relative to the melter gallery.

d The pressure in the melter plenum, the confinement zone for offgas, will be maintained at a nominal 5-in. w.g. negative pressure with respect to the melter annular spaces.

e For design plenum pressures, see 3.5 D 4 a below.

3 Deleted

4 Indoor Temperatures: Maximum melter gallery temperature will be 95°F (80°F for personnel occupancy).

5 Radiation Dosages: Enclosure plate thicknesses for permitting personnel access are defined in Section 3.5.B1.

6 Melter Utility Services:

a Contractor is currently providing the following services to the melters: electrical power, steam, cooling water, process water, ventilation air (annular space ventilation and controlled melter-in-leakage), demineralized water, purge air, instrument air, and argon.

b Pressure, flow, conditioning, and other control requirements will be adjusted by contractor to suit application at the delivery point.

c Subcontractor shall identify any other liquids or gases required over the melter lifetime.

d Subcontractor shall coordinate with contractor to define utilities that require normal service or backup services.

e Deleted.

f Subcontractor shall specify required service operating parameters at contract boundary, with contractor input on selected design operating criteria.

7 Deleted.

3.4 Mechanical Requirements

A Discharge Chamber and Glass Pour Spout

1 For baseline discharge chamber operation, glass discharge will alternate between the two chambers for every other canister. The switch between chambers will not occur until a canister has been filled.

2 Each discharge chamber shall be designed for a throughput of 15 metric tons per day.

3 Each melter discharge chamber can be enclosed in refractory.

4 Discharge chamber is designed to accommodate a pour spout assembly which is an enclosure that provides transition between melter and ILAW container.

5 Pour spout housing is designed to accommodate a viewing CCTV for monitoring glass pour stream and with an infrared camera to monitor glass fill level in the container.

B Feed Nozzles

1 Location and capacity of paired nozzles over each designated glass pool zone shall permit continued baseline throughput with only one of each pair of nozzles in operation, until scheduled maintenance is performed.

2 Contractor will provide the following for each feed nozzle:

a A dedicated feed line and pump.

b Cooling water.

c Air and water purge through the feed line.

3 Subcontractor shall coordinate with contractor to design glass frit addition system, for use during melter startup. Subcontractor shall be responsible for design of frit discharge "nozzle" that will penetrate enclosure and lid.

C Bubblers

1 Bubbler assemblies shall be isolated from the melter lid and lid jumpers to prevent electrical short-circuiting.

2 Coordinate with Contractor to define air/gas supply requirements.

D Plenum Viewing (Note: Plenum CCTVs are future components, not installed in melter at startup.)

1 Design four (4) closed circuit televisions (CCTVs) and associated systems for viewing plenum area and cold cap during operation.

2 CCTVs will be used on an intermittent basis, as operation and maintenance requirements dictate. Design CCTVs to be removable and replaceable using standard maintenance equipment with manual interface.

3 Viewing ports shall be purged to prevent buildup of solids and other contaminants.

4 Cool CCTV ports as required.

E Refractory Expansion Control System

1 Design jack bolts to actively control refractory expansion without operator intervention. Manual operation of, and safe access to, the bolts shall be maintained.

2 Coordinate with Contractor to provide a means of locally monitoring bolt movement.

F Melter Cooling Water System

1 A cooling system will be used to meet enclosure surface temperature limit of 140 F. Contractor will be responsible for water supply to the panels.

2 Cooling panels shall be designed and fabricated in accordance with Ref 2.1 D3 and 2.1 D7.

3 Cooling panel design shall be such that internal pressure and/or temperature induced distortions will not place undue stress on the melter refractory.

4 Design cooling panels to be emptied at melter change-out or decommissioning.

5 Coordinate with contractor for overall cooling water system design, including instrumentation and controls, external to the melter enclosure.

G Melter Ventilation Systems

1 The overall design objective for the ventilation and associated cooling system is to maintain melter enclosure surface temperature at or below 140 F. Discharge chamber lid design objective is to be at or below 210 F.

2 Subcontractor may take credit for ventilation cooling in achieving enclosure surface temperature requirements.

3 Provide melter air in-leakage requirements and total supply air flow rates to the melter annular spaces.

4 Coordinate melter design with contractor achieve adequate ventilation of discharge chambers during operation.

5 In coordination with contractor, optimize air in-leakage requirements:

a From the melter operating gallery (C3) to the melter and discharge chamber annular spaces (C5), accounting for access panel removal requirements.

b Account for "non-design" leakage paths into the melter plenum.

6 Provide a means for introducing passive air purges between the melter annular spaces and the melter plenum to lower concentration of corrosive plenum gases adjacent to metallic lid components.

H Melter Offgas System

1 Main and standby offgas lines are nominal 10-inch diameter.

2 Deleted.

3 Offgas pipe routing from the melter enclosure to the submerged bed scrubber will be defined by the contractor.

4 The film cooler design and configuration will reduce the offgas temperature and minimize solids deposition during the various modes of operation to support downstream offgas system operation.

5 Film cooler design shall incorporate a means for internal cleaning. This operation may be assisted with handling equipment in the melter gallery.

6 Discharge chambers shall be vented back to the melter plenum.

7 Provide means for measuring pressure in melter plenum and melter discharge chambers. Redundant pressure measurement shall be provided for the plenum.

8 Standby Film Cooler:

a Design standby film cooler for alternate ventilation path of melter exhaust during upset conditions.

b Provision shall be made for addition of up to 150 scfm of quench air to standby film cooler.

c Design standby film cooler to prevent solids buildup during slurry feeding (when melter exhaust flows through the primary film cooler).

d Standby film cooler shall endure radiant shine from the glass pool during melter idling.

I Piping

1 All cooling water piping, feed piping, pour flanges and offgas pipe downstream of film cooler shall be per Ref 2.1D1. Piping seismic design shall be in accordance with Ref 2.2G. Subcontractor shall provide documentation for justification of service class selected where different from what is shown.

2 To the extent practical, all joints shall be butt-welded.

3 Pipe Routing: Minimize abrupt changes in direction for pipe routed through the annular spaces of the melter, particularly feed lines.

4 Piping Slopes: Offgas piping within melter enclosure shall be sloped away from film cooler.

5 Deleted

6 Drains: Provide low-point "floor" drains between the gas barrier and enclosure and between the gas barrier and refractory to accommodate leaks from cooling water piping. Coordinate with contractor to provide leak detection equipment at the drains.

J Material Requirements

1 Subcontractor shall define all melter SSC material requirements in accordance with this Specification and applicable codes and standards. Where deviations are required, subcontractor shall notify contractor before proceeding with design.

2 Materials of construction shall be able to withstand the radioactive, thermal, and corrosive environment caused by the melter feed, glass, and offgases to ensure adequate performance and lifetime. Corrosion allowances for major structural components exposed to corrosive environments are as follows (2.2R):

Gas barrier Lid bottom plate, hot side (against refractory), 1/8"

Gas barrier Walls, 1/8"

Base plate, 1/8"

Cooling panels inside gas barrier, 1/32"

3 Subcontractor shall consider environmental, durability, corrosion and erosion factors during material selection with consideration of the following characteristics:

a Surface finish

b Chemical resistance

c Radiation resistance

d Pressure effects (cyclical)

e Temperature effects

f Hardness (possibility of galling and fretting)

g Fatigue (cyclic stresses both with and without the presence of aggressive chemicals).

4 Refractories shall be selected to meet melter design life based on experience from pilot melters and other operating units.

5 Deleted

3.5 Structural Requirements

A. General

1 Structural design of the melter shall be per 2.1D8, 2.1J, 2.2H and 2.2I.

2 The values of the parameters in *Seismic Analysis and Design Criteria* (2.2H) not specified therein shall be as follows:

a $R_p = 3.0$

b $h_x = 3.0$ ft

c $h_r = 68$ ft

d w_p = weight of SSC being analyzed

3 Deleted

4 Deleted

5 Deleted

6 Deleted

7 The design of the electrodes and the melter dam shall address creep over the life of the component.

B. Melter Enclosure

1 Enclosure Plate:

a Enclosure plate thickness over the top of film cooler and discharge chambers is 2 inch. On all other areas of melter, enclosure plate thickness is 1 inch.

b Not Used.

c Deleted.

d Provide suitable shielding barriers where no continuous structural weld is required.

e Top surface plates shall support all maintenance activities staged from the enclosure surface. See Ref 2.1E1.

2 Enclosure Penetrations:

a Where possible, design access panels to reach multiple components.

b Seat panels on lap joints for flush exterior surfaces.

c Coordinate with contractor for designing means for panel removal.

d Where possible, standardize penetration sizes to simplify operations and increase operating flexibility.

e Removable access panels have gaskets to minimize air in-leakage and shall include a means of lifting via crane of other lifting device. Coordinate with contractor for design and operation of access panels positioned below glass containment level.

f Install steel guide tubes between enclosure and melter structure for component positioning and air flow control.

C. Transportation System

1 Rollers/Wheels:

a Deleted

b Provide vertical adjustment capability (passive and/or active) to accommodate slight differences in transport rail elevation. The combined deflection and surface discontinuities are 0.0625 inch.

2 Fasteners, Anchors, and Positioning Devices: Coordinate with contractor to establish design and interface requirements for all phases of melter life.

3 Lifting Lugs: Subcontractor shall design and locate lifting lugs. Contractor will assume spreader bars will be used to carry out the lifts.

4 Refer to 2.2 M for interface details with rails.

D. Loadings

1 Dead Loads: Design shall consider the combined weight of all melter SSCs. Other static loads to be considered include:

a Temporary rigging equipment during transport.

b Weight corresponding to maximum glass volume during operations.

c Circulated cooling fluids during operations.

d Deleted.

2 Live Loads:

a Design top surface of melter enclosure for two localized loads of 6000 pounds each (representing two bubbler change-out arrangements or other comparably sized equipment) being placed on the melter adjacent to each other and in addition, a distributed load of 50 pounds per square foot, per Ref 2.1C.

b Analyze effects of drop loads on melter enclosure using a worst-case scenario of a loaded consumable change-out box corner impacting the lid after being dropped from a height of three (3) feet (total weight of 3,500 pounds). Enclosure shall retain confinement and operational integrity for this and lesser drop loads (Ref 2.2J).

c Subcontractor shall coordinate with contractor to develop loading requirements and limits related to transport, maintenance, decommissioning, and jumper attachment.

d Design the top enclosure surface of each discharge chamber to support a uniformly distributed load of 5,000 pounds.

3 Seismic loads: Melter seismic loads shall be determined as described in Section A2 above.

4 Pressure Gradients:

a The gas barrier walls, lid and base shall be designed to withstand a plenum pressure range of -40 inch w.g to +40 inch w.g.

b Deleted.

5 Other Loads:

a Thermal induced loads to be experienced during startup, normal operations, and idling.

b Piping reaction loads during normal operation.

c Lifting attachment locations for disposal and resulting load paths shall be designed with a minimum safety factor of 3, based on yield strength, or a safety factor of 5 based on ultimate strength.

d Not Used.

e Deleted.

f Loads imposed by contractor-supplied access platforms. The line loads for the east and west sides of the melter will be 300 lb/ft. The line load for the south side of the melter will be 320 lb/ft. No loads for the north side of the melter.

6 Not Used.

E. Load Combinations shall be per Section 5 of 2.2 I.

F. Deleted.

G. Deleted

H. Deleted.

I. Gas Barrier Lid

1 Section VIII, Divisions 1 and 2 of the ASME boiler and pressure vessel code shall be used as a guide for fabrication.

2 The lid water reservoir enclosure shall be rated for a maximum pressure of 14.5 psig.

3 Under normal operating conditions, cooling water expected flow is 25 gpm and 100°F at inlet. For thermal analysis of lid under flowing conditions, 15 gpm at 115°F inlet shall be used as a conservative basis.

4 The lid shall be designed to maintain structural integrity for a minimum of 2 hours after a loss of cooling upset event.

5 The inlet and outlet of the melter lid cooling cavity must be elevated near the top of the cavity, to limit loss of water mass in the lid cooling cavity should a leak develop in the cooling water circuit

3.6 Electrical Requirements

See Appendix A for melter service and connection details and Appendix B for the balance of melter design interface details.

NOTE: The electrical-related information in these appendices were used initially as a basis for design. Refer to melter electrical drawings for final design configuration and component details. These drawings may be found under the following general document numbering systems:

24590-101-TSA-W000-0010-409-[3 and 4 digit indexing]
24590-QL-HC4-W000-00011-03-[2, 3, and 5 digit indexing]

24590-LAW-MX-LMP-[8 digit indexing]

A General

1 The following code references apply to this section: Refs 2.1B1 through 2.1B6, 2.1E2, 2.1G1, 2.1G2, 2.1H1, 2.1H2, and 2.1I.

2 Subcontractor shall specify the following:

a Wave form, frequency and current density for electrical power supplied at electrodes.

b Deleted.

c Electrode firing configuration.

d Instrumentation and control requirements for the power source to the electrodes, discharge heaters, and startup heaters.

B Electrode Power

1 Electrodes, extension buses, and bus jumpers shall be capable of carrying the current at the voltage required for all modes of melter operation.

2 Minimize connection resistance between extension bus and bus jumper, as well as between the extension bus and electrode if they are two separate components.

3 Connections between extension buses and bus jumpers shall allow for expansion and contraction of the extension bus.

4 Bus jumpers shall be designed with provisions for installing a connector on the end passing through the melter shielding.

5 Extension buses shall be electrically isolated from the melter enclosure and structure.

6 Bus jumpers shall be insulated over their entire length and shall be electrically isolated from the melter enclosure and structure.

7 Electromagnetic Coupling: Coupling between extension buses, bus jumpers and the materials they pass through shall be limited to prevent negative effects on melter life or performance.

8 Electromagnetic Interference: To the extent practical, bus jumpers shall be routed to maximize magnetic field cancellation.

9 Cooling:

a Electrode extensions shall be air cooled

b Deleted.

C Discharge Heater Power

1 Maximum discharge heater operating voltage is 480 VAC.

2 Discharge heaters shall be matched to the extent practical with respect to resistance, operating current, and voltage.

3 Each discharge heater assembly shall be designed with a plug-type connector integral to the heater assembly.

4 Discharge heaters shall be electrically isolated from each other and from the melter enclosure and structure.

5 The discharge heater jumpers shall have plug-type connectors on each end.

6 Connectors on the heater side of the discharge heater jumpers shall mate with the connector integral to the heater.

7 The junction box design shall include a metal bracket suitable for rigid mounting of discharge heater jumper connectors.

8 The junction box shall be sized to contain the required number of incoming and outgoing cables with their associated connectors.

9 Penetration through the melter shielding shall be sized to contain all the discharge heater jumpers, and sealed for contamination and radiation containment.

D Startup Heater Power

1 Startup heaters shall be matched to the extent practical with respect to resistance, operating current, and voltage.

2 Each startup heater shall be designed with a plug-type connector with a three foot flying lead integral to the heater assembly.

3 Startup heaters shall be electrically isolated from each other and from the melter enclosure and structure.

4 Startup heater jumpers shall have plug-type connectors on each end.

5 Connectors on the heater side of the startup heater jumpers shall mate with connectors integral to the heater.

6 Connectors on the shielding side of the startup heater jumpers shall be suitable for mounting to metal inserts in shielding penetrations. The integral connector and insert design shall seal the penetration, for contamination and radiation containment.

E Cable

1 Refer to Ref 2.1G1 for general cable design standards.

2 Cables routed within the melter enclosure and structure shall be rated for the maximum ambient temperature encountered.

3 Cable insulation and jacket material shall be of the low-flammability type, per Ref 2.1B5.

4 Cable insulation and jacket material shall be resistant to heat, moisture, impact, radiation, and ozone, as required for the expected operating environment.

5 Cables shall be supported or routed in raceway within the melter enclosure.

6 Power cables of size # 2/0 and larger will be single conductor or triplexed.

7 Instrument cables shall be single pair, triad-twisted and shielded, or multi pair with shielded pair and overall shield and drain wire.

8 Control cables shall be multi-conductor and color coded in accordance with Ref 2.1G2, Standard Method. Coordinate with contractor to determine requirements for spare conductors in multi-conductor control and instrumentation cables.

9 Instrument and thermocouple cables shall be single pair twisted, shielded, or multi-pair cable with individual pair shielded and overall shield.

10 Minimum Conductor Sizes:

a #12 AWG for power circuits.

b #14 AWG for control circuits (120 VAC, 125 VDC) and instrument power circuits.

c #18 AWG for instrumentation – single pair cable.

d #20 AWG for instrumentation – multi pair cable.

Note: Instrumentation conductors include low-level voltage, current, or digital electrical signal connections to sensing and actuating devices.

11 Cables shall be physically separated in accordance with the function and voltage class as follows:

a Low-voltage power AC and DC cables.

b High-level signal and control or discrete on/off control cables (120 V AC, 125 V DC).

c Controls with critical safety requirements as determined by contractor.

d Cables for general instrumentation (i.e., low-level analog and digital signals and data communication).

F Raceway Within Melter Envelope

1 To the extent practical, cable trains for different power source groups shall be routed in separate raceways. Raceways shall be physically separated in accordance with the function and voltage class of the cables contained within, as follows:

a Low-voltage power AC and DC-600 V cables.

b High-level signal and control or discrete on/off control cables (120 V AC, 125 V DC).

c Controls with critical safety requirements as determined by contractor.

d Cables for general instrumentation (i.e., low-level analog and digital signals, building evacuation, data communication, environmental surveillance system fiber for digital data communication)

2 Raceways shall be rigid metallic conduit and shall be a minimum of 1/2 inch in size. Wire trough or other approved wiring methods may be used where necessary.

3 Raceways shall be supported as required, per Ref 2.1H1.

4 Raceway designated for a single class of cables shall contain only cables of the same class.

G Junction Boxes

1 Junction boxes are used to connect jumpers from the instrumentation and discharge heaters within the enclosure to cabling external to the melters.

2 Boxes shall be supported as required, and sized and bonded to the shielding in accordance with Ref 2.1H1.

H Grounding

1 Metal sections of the melter enclosure and structure shall be electrically interconnected.

2 Provisions at four (4) locations on the melter shall be made to allow connection to the facility ground system.

3 Ground connections shall be made with pressure-type connectors.

3.7 Controls and Instrumentation Requirements

A Controls Requirements

For melter design requirements related to control logic, sequence of operations, and control software and hardware, see Ref 2.2B. Controls system design is in contractor's scope unless stated otherwise in Ref 2.2B.

B Instrumentation Requirements.

For melter design requirements related to instrumentation, see Ref 2.2B.

3.8 Maintenance Requirements

A General

1 All nonstructural SSCs are designed for safe and effective maintenance per 24590-WTP-RPT-OP-01-001, *Operations Requirements Document*. To the extent practical, the design of the melter and its ancillary components will utilize techniques for minimizing maintenance labor to reduce the time, number and type of crafts required to perform work:

a Minimize downtime, and impacts to overall operation of the facility.

b Keep maintenance activities simple and straightforward.

c Minimize requirement for special tools and equipment for maintenance.

d Modularize SSCs for maintenance, access, and replacement.

e Demonstrate best possible access to controls, protective interlocks, and SSCs for maintenance.

f Minimize impact on interfacing SSCs while performing maintenance on targeted SSCs.

g Allow for the gathering of diagnostic information where possible to determine melter life.

h Incorporate features to aid in replacement of SSCs that do not meet the melter design life of 5 years. Contractor will be providing a consumable changeout box for replacement of most consumables mounted in the melter lid.

2 Subcontractor shall perform failure modes and effects analyses on the critical SSCs identified in the contract:

a Specify what critical SSCs need to be maintained and inspected, specify maintenance and inspection requirements, and provide data on predicted availability.

b Identify potential failures for critical SSCs, and recovery sequences.

c Identify and implement sufficient redundancy requirements to minimize impact on glass production.

3 Melter maintenance operations, planned or unplanned, shall not compromise enclosure containment (assuming ventilation system is functioning normally) and will allow for access to equipment for maintenance operations where hands-on operations do not compromise worker safety. Subcontractor shall interface with contractor to ensure that access around melters is sufficient for daily visual inspection of all melter enclosure surfaces.

4 Subcontractor shall identify all special tools and equipment for maintenance.

5 Components and equipment exceeding 42 pounds, or a temperature of 110 °F, or having excessive sharp edges shall have lifting bails designed to interface with overhead maintenance crane/manipulator.

6 Subcontractor shall coordinate with contractor to optimize melter maintenance access, taking into account facility layout and maintenance support equipment and services outside of the subcontractor's scope of work.

B Baseline Component Design Lives

Refer to 2.2N

4 Quality Assurance Requirements

4.1 General

A Subcontractor and sub-tier vendors shall perform all design work in accordance with a contractor-approved quality assurance plan which meets the applicable requirements of Ref 2.1D4.

B Subcontractor shall be responsible for all sub-tier vendor quality assurance requirements during design.

C Refer to the contract for quality assurance requirements pertaining to specific melter SSCs (24590-QL-HC4-W000-00011).

D The contractor reserves the right to review design work in progress to assess the effectiveness of the subcontractor's quality system at any time during the design process. Assessments performed by the contractor shall in no way relieve the subcontractor of any contractual responsibilities.

5 Documentation and Submittals

5.1 General Documentation Requirements

A. Refer to the contract for submittal format, transmission, and review requirements.

5.2 Submittals

A. Refer to the contract for specific melter system submittal requirements.

Appendix A- Melter Services and Connections Interface Details

Melter Engineering Specification Appendix Note:

The data in this appendix are based on experience from pilot melters and other operating units. This data was gathered early in the project and used as a guide for design of surrounding utilities. The values should not be used directly as input since in many cases the design has continued to evolve and there may be inconsistencies between issued design documents and values in these tables. Instead, refer to the appropriate design media, e.g. P&IDs, melter design drawings, melter design calculations, or other system calculations. These data may be used as an assumption for performing calculations but the assumption will require verification by the calculation where it was used or other design media.

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
agi19	air supply - bubbler #01	WB1	WB1	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi20	air supply - bubbler #02	WB2	WB2	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi21	air supply - bubbler #03	WB3	WB3	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi22	air supply - bubbler #04	WB4	WB4	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi23	air supply - bubbler #05	WB5	WB5	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi24	air supply - bubbler #06	CB6	CB6	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi25	air supply - bubbler #07	CB7	CB7	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUF	LWA	Staubli	Custom Pitless Fitting	45
agi26	air supply - bubbler #08	CB8	CB8	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi27	air supply - bubbler #09	CB9	CB9	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi28	air supply - bubbler #10	CB10	CB10	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi29	air supply - bubbler #11	CB11	CB11	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi30	air supply - bubbler #12	CB12	CB12	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi31	air supply - bubbler #13	CB13	CB13	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi32	air supply - bubbler #14	EB14	EB14	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi33	air supply - bubbler #15	EB15	EB15	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi34	air supply - bubbler #16	EB16	EB16	1/2	C	IA-2	0.75	[illegible]	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi35	air supply - bubbler #17	EB17	EB17	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
agi36	air supply - bubbler #18	EB18	EB18	1/2	C	IA-2	0.75	scfm	4	psig	113 (45)	0.1-3	scfm	10	psig	150 (66)	TRUE	LWA	Staubli	Custom Pitless Fitting	45
clg01	water return - cooling, base	NEB-1	NEB-1	2	C	CW-1	40	gpm	100	psig	99 (37)	40	gpm	150	psig	360 (182)	TRUE	NEB-1	Hiltap	N/A	12 48
clg02	water supply - cooling, base	NWB-1	NWB-1	2	C	CW-1	40	gpm	100	psig	84 (29)	40	gpm	150	psig	360 (182)	TRUE	NWB-1	Hiltap	N/A	1 48
clg03	water return - cooling, east discharge	N/A	clg03	2	C	CW-1	15	gpm	100	psig	95 (35)	15	gpm	150	psig	360 (182)	TRUE	SE-1	Hiltap	N/A	12 48
clg04	water supply - cooling, east discharge	N/A	clg04	2	C	CW-1	15	gpm	100	psig	84 (29)	15	gpm	150	psig	360 (182)	TRUE	SE-1	Hiltap	N/A	1 48
clg05	water return - cooling, east wall	N/A	clg05	1	C	CW-1	10	gpm	100	psig	105 (41)	10	gpm	150	psig	360 (182)	TRUE	EN-1	Hiltap	N/A	12 48
clg06	water supply - cooling, east wall	N/A	clg06	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	EN-1	Hiltap	N/A	1 48
clg07	water return - cooling, northeast wall	N/A	clg07	1	C	CW-1	10	gpm	100	psig	99 (37)	10	gpm	150	psig	360 (182)	TRUE	NE-1	Hiltap	N/A	12 48
clg08	water supply - cooling, northeast wall	N/A	clg08	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NE-1	Hiltap	N/A	1 48
clg09	water return - cooling, northwest wall	NW-1	clg09	1	C	CW-1	10	gpm	100	psig	99 (37)	10	gpm	150	psig	360 (182)	TRUE	NW-1	Hiltap	N/A	12 48
clg10	water supply - cooling, northwest wall	NW-1	clg10	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NW-1	Hiltap	N/A	1 48
clg11	water return - cooling, southeast wall	N/A	clg11	1	C	CW-1	10	gpm	100	psig	93 (34)	10	gpm	150	psig	360 (182)	TRUF	SE-1	Hiltap	N/A	12 48

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
clg12	water supply - cooling, southeast wall	N/A	clg12	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	SE-1	Hiltap	N/A	1 48
clg13	water return - cooling, southwest wall	N/A	clg13	1	C	CW-1	10	gpm	100	psig	93 (34)	10	gpm	150	psig	360 (182)	TRUE	SW-1	Hiltap	N/A	12 48
clg14	water supply - cooling, southwest wall	N/A	clg14	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	SW-1	Hiltap	N/A	1 48
clg17	water return - cooling, west discharge	N/A	clg17	2	C	CW-1	15	gpm	100	psig	95 (35)	15	gpm	150	psig	360 (182)	TRUE	SW-1	Hiltap	N/A	12 48
clg18	water supply - cooling, west discharge	N/A	clg18	2	C	CW-1	15	gpm	100	psig	84 (29)	15	gpm	150	psig	360 (182)	TRUE	SW-1	Hiltap	N/A	1 48
clg19	water return - cooling, west wall	N/A	clg19	1	C	CW-1	10	gpm	100	psig	105 (41)	10	gpm	150	psig	360 (182)	TRUE	WN-1	Hiltap	N/A	12 48
clg20	water supply - cooling, west wall	N/A	clg20	1	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	WN-1	Hiltap	N/A	1 48
clg21	water supply - cooling, lid	N/A	clg21	1-1/2	C	CW-1	25	gpm	14.5	psig	84 (29)	25	gpm	14.5	psig	140 (60)	TRUE	NW-2	Hiltap	N/A	1 48
clg22	water return - cooling, lid	N/A	clg22	1.5	C	CW-1	25	gpm	14.5	psig	90 (32)	25	gpm	14.5	psig	140 (60)	TRUE	NE-2	Hiltap	N/A	12 48
clg23	water supply - cooling, plenum	N/A	clg23	2	C	CW-1	70	gpm	100	psig	84 (29)	70	gpm	150	psig	360 (182)	TRUE	WS-1	Hiltap	N/A	1 48
clg24	water return - cooling, plenum	N/A	clg24	2	C	CW-1	70	gpm	100	psig	85 (29)	70	gpm	150	psig	360 (182)	TRUE	ES-1	Hiltap	N/A	12 48
clg26	water supply - cooling, west offgas shielded lid panel	NW-2	clg26	3/4	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NW-2	Hiltap	N/A	1 48
clg27	water return - cooling, west offgas shielded lid panel	NW-2	clg27	3/4	C	CW-1	10	gpm	100	psig	90 (32)	10	gpm	150	psig	360 (182)	TRUE	NW-2	Hiltap	N/A	12 48
clg28	water return - cooling panel total return based on 84F supply	N/A	clg28	N/A	N/A	CW-1	245	gpm	N/A		105.4 (41)	245	gpm	N/A		N/A	TRUE	N/A	N/A	N/A	
clg29	water supply - cooling, east offgas shielded lid panel	NE-2	clg29	3/4	C	CW-1	10	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NE-2	Hiltap	N/A	1 48
clg30	water return - cooling, east offgas shielded lid panel	NE-2	clg30	3/4	C	CW-1	10	gpm	100	psig	90 (32)	10	gpm	150	psig	360 (182)	TRUE	NE-2	Hiltap	N/A	12 48
clg31	water supply - cooling, west film cooler cover panel	NE-2	clg31	3/4	C	CW-1	2	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NE-2	Hiltap	Staubli	
clg32	water return - cooling, west film cooler cover panel	NE-2	clg32	3/4	C	CW-1	2	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NE-2	Hiltap	Staubli	
clg33	water supply - cooling, east film cooler cover panel	NW-2	clg33	3/4	C	CW-1	2	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NW-2	Hiltap	Staubli	
clg34	water return - cooling, east film cooler cover panel	NW-2	clg34	3/4	C	CW-1	2	gpm	100	psig	84 (29)	10	gpm	150	psig	360 (182)	TRUE	NW-2	Hiltap	Staubli	
clg35	water return, cooling, west seal head panel	Lower	clg35	1	C	CW-1												N/A	Hiltap		38
clg36	water supply, cooling, west seal head panel	Upper	clg36	1	C	CW-1												N/A	Hiltap		38
clg37	water supply, cooling, east seal head panel	Upper	clg37	1	C	CW-1												N/A	Hiltap		38
clg38	water return, cooling, east seal head panel	Lower	clg38	1	C	CW-1												N/A	Hiltap		38
drn01	drain - gas barrier annulus	N/A	drn01	2	Rare	DR	N/A		N/A		N/A	N/A		+10/-40	in wc	113 (45)	FALSE	N/A	B16.5 150#	N/A	
drn02	drain - melter shielding	N/A	drn02	2	Rare	DR	N/A		N/A		N/A	N/A		+10/-40	in wc	113 (45)	FALSE	N/A	B16.5 150#	N/A	
fed01	water return - feed nozzle #1 cooling	WF1-B	WF1-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 48
fed02	water supply - feed nozzle #1 cooling	WF1-A	WF1-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed03	feed supply - feed nozzle #1	WF1	WF1	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed05	water return - feed nozzle #2 cooling	WF2-B	WF2-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 48
fed06	water supply - feed nozzle #2 cooling	WF2-A	WF2-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed07	feed supply - feed nozzle #2	WF2	WF2	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed08	water return - feed nozzle #3 cooling	CF3-B	CF3-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 48

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
fed09	water supply - feed nozzle #3 cooling	CF3-A	CF3-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed10	feed supply - feed nozzle #3	CF3	CF3	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed12	water return - feed nozzle #4 cooling	CF4-B	CF4-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 48
fed13	water supply - feed nozzle #4 cooling	CF4-A	CF4-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed14	feed supply - feed nozzle #4	CF4	CF4	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed15	water return - feed nozzle #5 cooling	EF5-B	EF5-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 45
fed16	water supply - feed nozzle #5 cooling	EF5-A	EF5-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed17	feed supply - feed nozzle #5	EF5	EF5	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed19	water return - feed nozzle #6 cooling	EF6-B	EF6-B	3/4	C	CW-1	5.5	gpm	100	psig	86 (30)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	13 48
fed20	water supply - feed nozzle #6 cooling	EF6-A	EF6-A	3/4	C	CW-1	5.5	gpm	100	psig	84 (29)	7.5	gpm	150	psig	360 (182)	TRUE	LWW	Hiltap	Swagelok	1 48
fed21	feed supply - feed nozzle #6	EF6	EF6	3/4	I	Normal	1	gpm	30	psig	113 (45)	1	gpm	100	psig	150 (66)	FALSE	FEED	Hiltap	Swagelok	
fed22	frit addition funnel #1	N/A	fed22	custom	Rare	M	N/A		-5	in wc	113 (45)	N/A		+10/-40	in wc	113 (45)	FALSE	N/A	Custom	Custom	6 30
fed23	frit addition funnel #2	N/A	fed23	custom	Rare	M	N/A		-5	in wc	113 (45)	N/A		+10/-40	in wc	113 (45)	FALSE	N/A	Custom	Custom	6 30
fed48	water supply - feed nozzle flush (each nozzle)	N/A	fed48	N/A	I	PW	1/4	gph	30	psig	84 (29)	1/4	gph	150	psig	360 (182)	FALSE	N/A	N/A	N/A	50
fed49	water supply - feed nozzle start up from idle (each nozzle)	N/A	fed49	N/A	I	PW	1	gpm	30	psig	84 (29)	1	gpm	150	psig	360 (182)	FALSE	N/A	N/A	N/A	51
grd01	melter ground (4 locations)	N/A	grd01	N/A	C	E	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	cable lug	N/A	
htd01	heater - east discharge auxiliary	N/A	htd01	#10	Rare	E	0	A	0	V	N/A	17.5	A	240	V	N/A	FALSE	EDH	Lemo	N/A	11
htd02	heater - east discharge #01	N/A	htd02	#2	C	E	25-30	A	70-85	V	N/A	50	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd03	heater - east discharge #02	N/A	htd03	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd04	heater - east discharge #03	N/A	htd04	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd05	heater - east discharge #04	N/A	htd05	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd06	heater - east discharge #05	N/A	htd06	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd07	heater - east discharge #06	N/A	htd07	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd08	heater - east discharge #07	N/A	htd08	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd09	heater - east discharge #08	N/A	htd09	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd10	heater - east discharge #09	N/A	htd10	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd11	heater - east discharge #10	N/A	htd11	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd12	heater - east discharge #11	N/A	htd12	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd13	heater - east discharge #12	N/A	htd13	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	EDH	Vantage	Vantage	
htd14	heater - west discharge auxiliary	N/A	htd14	#10	Rare	E	0	A	0	V	N/A	17.5	A	240	V	N/A	FALSE	WDH	Lemo	N/A	11

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Svc	Connect Box Number	Externl Style (10)	Internal Style	Notes
htd15	heater - west discharge #01	N/A	htd15	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd16	heater - west discharge #02	N/A	htd16	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd17	heater - west discharge #03	N/A	htd17	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd18	heater - west discharge #04	N/A	htd18	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd19	heater - west discharge #05	N/A	htd19	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd20	heater - west discharge #06	N/A	htd20	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd21	heater - west discharge #07	N/A	htd21	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd22	heater - west discharge #08	N/A	htd22	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd23	heater - west discharge #09	N/A	htd23	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd24	heater - west discharge #10	N/A	htd24	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd25	heater - west discharge #11	N/A	htd25	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htd26	heater - west discharge #12	N/A	htd26	#2	C	E	25-30	A	70-85	V	N/A	59	A	480	V	N/A	FALSE	WDH	Vantage	Vantage	
htm01	power - electrode bus, northcenter	N/A	htm01	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm04	TC - northcenter electrode extension cooling air exhaust	N/A	htm04	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	NCE	Lemo	Lemo	
htm05	air supply - electrode extension cooling, northcenter	CE-1	CE1	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	NE-1	Staubli	Staubli	
htm06	TC - northcenter electrode extension	N/A	htm06	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	NCE	Lemo	Lemo	
htm07	power - electrode bus, northeast	N/A	htm07	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm10	TC - northeast electrode extension cooling air exhaust	N/A	htm10	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ENE	Lemo	Lemo	
htm11	air supply - electrode extension cooling, northeast	EE-1	EE1	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	EN-2	Staubli	Staubli	
htm12	TC - northeast electrode extension	N/A	htm12	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ENE	Lemo	Lemo	
htm13	power - electrode bus, northwest	N/A	htm13	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm16	TC - northwest electrode extension cooling air exhaust	N/A	htm16	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WNE	Lemo	Lemo	
htm17	air supply - electrode extension cooling, northwest electrode	WE-1	WE1	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	WN-2	Staubli	Staubli	
htm18	TC - northwest electrode extension	N/A	htm18	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WNE	Lemo	Lemo	
htm19	power - electrode bus, southcenter	N/A	htm19	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm22	TC - southcenter electrode extension cooling air exhaust	N/A	htm22	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	SCE	Lemo	Lemo	
htm23	air supply - electrode extension cooling, southcenter electrode	CE-2	CE2	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	SW-1	Staubli	Staubli	

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
htm24	TC - southcenter electrode extension	N/A	htm24	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	SCE	Lemo	Lemo	
htm25	power - electrode bus, southeast	N/A	htm25	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm28	TC - southeast electrode extension cooling air exhaust	N/A	htm28	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ESE	Lemo	Lemo	
htm29	air supply - electrode extension cooling, southeast electrode	EE-2	EE2	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	ES-2	Staubli	Staubli	
htm30	TC - southeast electrode extension	N/A	htm30	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ESE	Lemo	Lemo	
htm31	power - electrode bus, southwest	N/A	htm31	2" bus	C	E	989-5761	A	103-440	V	N/A	6500	A	480	V	N/A	TRUE	N/A	Custom	Custom	67
htm34	TC - southwest electrode extension cooling air exhaust	N/A	htm34	N/A	C	TC	N/A		N/A	in wc	N/A	N/A		N/A		N/A	FALSE	WSE	Lemo	Lemo	
htm35	air supply - electrode extension cooling, southwest electrode	WE-2	WE2	3/4	C	IA-2	10	scfm	10	psig	113 (45)	10	scfm	15	psig	150 (66)	FALSE	WS-2	Staubli	Staubli	
htm36	TC - southwest electrode extension	N/A	htm36	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WSE	Lemo	Lemo	
hts01	heater - startup #01	WB-1	hts01	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts02	heater - startup #02	WB-2	hts02	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts03	heater - startup #03	WB-3	hts03	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts04	heater - startup #04	WB-4	hts04	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts05	heater - startup #05	WB-5	hts05	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts06	heater - startup #06	CB-6	hts06	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts07	heater - startup #07	CB-7	hts07	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts08	heater - startup #08	CB-8	hts08	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts09	heater - startup #09	CB-9	hts09	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts10	heater - startup #10	CB-10	hts10	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts11	heater - startup #11	CB-11	hts11	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts12	heater - startup #12	CB-12	hts12	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts13	heater - startup #13	CB-13	hts13	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts14	heater - startup #14	EB-14	hts14	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts15	heater - startup #15	EB-15	hts15	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts16	heater - startup #16	EB-16	hts16	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts17	heater - startup #17	EB-17	hts17	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
hts18	heater - startup #18	EB-18	hts18	#1	Rare	E	99-124	A	94-117	V	N/A	142	A	480	V	N/A	FALSE	N/A	Cooper Crouse Hinds	N/A	6 29
lkd08	leak detector - gas barrier annulus	N/A	lkd08	#16	C	E	0	A	12	V	N/A	1	A	120	V	N/A	FALSE	NE	Lemo	N/A	
lkd11	leak detector - shielding annulus	N/A	lkd11	#16	C	E	0	A	12	V	N/A	1	A	120	V	N/A	FALSE	NE	Lemo	N/A	
lvl01	argon supply - level detector, density leg	WL1-B	WL1-B	3/8	C	Ar	1.8	scfh	2	psig	113 (45)	1.8	scfh	5	psig	150 (66)	TRUE	LWA	Staubli	Staubli	66
lvl02	argon supply - level detector, level leg	WL1-C	WL1-C	3/8	C	Ar	1.8	scfh	3	psig	113 (45)	1.8	scfh	5	psig	150 (66)	TRUE	LWA	Staubli	Staubli	66

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
lvl03	air supply - level detector, reference leg (R1)	WL1-A	WL1-A	3/8	C	IA-1	0 2	scfh	1	psig	113 (45)	0 2	scfm	15	psig	150 (66)	FALSE	LWA	Staubli	Staubli	
lvl04	spare - level detector, density leg	ES8-B	ES8-B	3/8	Rare	Ar	1 8	scfh	2	psig	113 (45)	1.8	scfh	5	psig	150 (66)	TRUE	LWA	Staubli	Staubli	66
lvl05	spare - level detector, level leg	ES8-C	ES8 C	3/8	Rare	Ar	1 8	scfh	3	psig	113 (45)	1 8	scfh	5	psig	150 (66)	TRUE	LWA	Staubli	Staubli	66
lvl06	spare - level detector, reference leg	ES8-A	ES8-A	3/8	Rare	IA-1	0 2	scfm	1	psig	113 (45)	0.2	scfm	15	psig	150 (66)	FALSE	LWA	Staubli	Staubli	
ogp01	air supply - primary offgas film cooler see ogp09, ogp14	EO-2	ogp01	3																	
ogp02	water supply - primary offgas film cooler wash, same connection as ogp11, ogp12	EO-2	ogp02	3/4	I	PW	3-4	gpm	50	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NE-2	Staubli	Staubli	
ogp05	water supply - primary offgas line wash, same connection as ogp10, ogp15	EO-2	ogp05	3/4	I	PW	3-4	gpm	50	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NE-2	Staubli	Staubli	
ogp06	power - primary offgas film cooler cleaner	EO-2	ogp06	N/A	Rare	E	5	A	480	V	N/A	N/A		N/A		N/A	FALSE	N/A	Lemo	N/A	
ogp08	offgas - primary line/film cooler	EO-2	ogp08	10 sch 80	C	OG	1056	scfm	-5	in wc	572 (300)	5154	scfm	+10/-40	in wc	1112(600)	FALSE	N/A	Hiltap	Hiltap	
ogp09	air supply - primary offgas melter pressure control, same connection as ogp01, ogp14	EO-2	ogp09	3	C	PA	300	scfm	5	psig	113 (45)	400	scfm	150	psig	150 (66)	FALSE	NE-2	Hiltap	Graylok	
ogp10	air supply - primary offgas line wash nozzle blowdown, same connection as ogp05, ogp15	EO-2	ogp10	3/4	I	PA	10	scfm	100	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NE-2	N/A	N/A	
ogp11	air supply - primary film cooler wash nozzle purge, same connector as ogp02, ogp12	EO-2	ogp11	3/4	I	PA	4	scfm	20	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NE-2	N/A	N/A	
ogp12	air supply - primary film cooler wash nozzle blowdown, same connection as ogp02, ogp11	EO-2	ogp12	3/4	I	PA	10	scfm	100	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NE-2	N/A	N/A	
ogp14	air supply - primary film cooler, same connection as ogp01, ogp09	EO-2	ogp14	3	C	PA	155	scfm	100	psig	302 (150)	600	scfm	150	psig	302 (150)	FALSE	NE-2	Hiltap	Graylok	68
ogp15	air supply - primary offgas line wash nozzle purge, same connection as ogp05, and ogp10	EO-2	ogp15	3/4	I	PA	4	scfm	20	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NE-2	N/A	N/A	
ogs01	air supply - standby film cooler	WO-1	ogs01	3	C	PA	30/150	scfm	5	psig	113 (45)	150	scfm	150	psig	150 (66)	FALSE	NW-2	Hiltap	Graylok	
ogs02	water supply - standby film cooler wash nozzle, same connection as ogs08 ogs12	WO-1	ogs02	3/4	I	PW	3-4	gpm	50	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NW-2	Staubli	Staubli	
ogs03	air supply - standby offgas melter pressure measurement (R2)	WO-1	R2	3/8	C	IA-1	0 2	scfm	1	psig	113 (45)	0.2	scfm	150	psig	150 (66)	FALSE	NW-2	Staubli	Staubli	27
ogs06	water supply - standby offgas line wash, same connection as ogs11, ogs13	WO-1	ogs06	3/4	I	PW	3-4	gpm	50	psig	84 (29)	10	gpm	150	psig	360 (182)	FALSE	NW-2	Staubli	Staubli	
ogs07	power - standby offgas film cooler cleaner	WO-1	ogs07	N/A	Rare	E	5	A	480	V	N/A	N/A		N/A		N/A	FALSE	N/A	Lemo	N/A	
ogs08	air supply - standby film cooler wash nozzle blowdown, same connection as ogs02, ogs12	WO-1	ogs08	3/4	I	PA	10	scfm	100	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NW-2	N/A	N/A	
ogs09	offgas - standby line/film cooler	WO-1	ogs09	10 sch 80	C/U	OG	0	scfm	-5	in wc	113 (45)	4960	scfm	+10/-40	in wc	1112	FALSE	N/A	Hiltap	Hiltap	
ogs11	air supply - standby offgas line wash nozzle blowdown, same connection as ogs06, ogs13	WO-1	ogs11	3/4	C	PA	32	scfm	5	psig	113 (45)	50	scfm	150	psig	150 (66)	FALSE	NW-2	N/A	N/A	
ogs12	air supply - standby film cooler wash nozzle purge, same connection as ogs02, ogs08	WO-1	ogs12	3/4	I	PA	4	scfm	20	psig	113 (45)	10	scfm	150	psig	150 (66)	FALSE	NW-2	N/A	N/A	
ogs13	air supply - standby offgas line wash nozzle purge, same connection as ogs06, ogs11	WO-1	ogs13	3/4	I	PA	4	scfm	20	psig	113 (45)	4	scfm	150	psig	150 (66)	FALSE	NW-2	N/A	Staubli	
ogs15	air supply - melter ITS plenum pressure (R5)	WS-1	WS1	3/8	C	IA-1	0 2	scfm	1	psig	113 (45)	0.2	scfm	15	psig	113 (45)	FALSE	LWA	Staubli	Staubli	
ogs16	air supply - melter ITS shielding pressure reference (R6)	RB-6	RB6	3/8	C	IA-1	0 2	scfm	1	psig	113 (45)	0.2	scfm	15	psig	113 (45)	FALSE	LWA	Staubli	N/A	
por01	air supply - air lift/riser purge gas, east	EA-2	EA2	1/2	I	IA-2	3	scfm	2	psig	113 (45)	3	scfm	5	psig	150 (66)	FALSE	LWA	Staubli	Staubli	14 52
por02	port - east discharge lid	N/A	por02	N/A	N/A	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
por04	port - east discharge lid cleanout/inspection plug	N/A	por04	N/A	Rare	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	
por05	port - west discharge lid cleanout/inspection plug	N/A	por05	N/A	Rare	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	
por06	port - east discharge lid spare plug	N/A	por06	N/A	Rare	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	
por07	port - west discharge lid spare plug	N/A	por07	N/A	Rare	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	
por08	vent - east discharge lid return to plenum	E04	EO4	2	C	OG	58	acfm	-5	in wc	932 (500)	58	acfm	+10/-40	in wc	1112(600)	FALSE	N/A	N/A	Graylok	
por09	air supply - air lift/riser purge gas, west	WA-1	WA1	1/2	I	IA-2	3	scfm	2	psig	113 (45)	3	scfm	5	psig	150 (66)	FALSE	LWA	Staubli	Staubli	14 52
por10	port - west discharge lid	N/A	por10	N/A	N/A	M	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	N/A	N/A	N/A	
por14	argon supply - air lift/riser purge gas, east, same connection as por01	EA-2	por14	3/8	I	Ar	0.2	scfh	2	psig	113 (45)	0.2	scfh	5	psig	150 (66)	TRUE	LWA	N/A	N/A	14 56
por15	argon supply - air lift/riser purge gas, west, same connection as por09	WA-1	por15	3/8	I	Ar	0.2	scfh	2	psig	113 (45)	0.2	scfh	5	psig	150 (66)	TRUE	LWA	N/A	N/A	14 06
prm01	air supply - pressure measurement, east discharge chamber	ED-1	ED1	3/8	C	IA-2	0.2	scfh	1	psig	113 (45)	1	scfh	150	psig	150 (66)	FALSE	SE-1	Staubli	Staubli	
prm02	air supply - pressure reference, east discharge chamber	ED-2	ED2	3/8	C	IA-2	0.2	scfm	1	psig	113 (45)	0.2	scfm	150	psig	150 (66)	FALSE	SE-1	Staubli	N/A	
prm03	air supply - shielding annulus reference leg (R3)	R3	R3	3/8	C	IA-1	0.2	scfm	1	psig	113 (45)	0.2	scfm	1	psig	150 (66)	FALSE	LWA	Staubli	Staubli	
prm04	air supply - shielding annulus reference leg (R4)	R4	R4	3/8	C	IA-1	0.2	scfm	1	psig	113 (45)	0.2	scfm	1	psig	150 (66)	FALSE	LWA	Staubli	N/A	
prm05	air supply - pressure measurement, west discharge chamber	WD-1	WD1	3/8	C	IA-2	0.2	scfh	1	psig	113 (45)	1	scfh	150	psig	150 (66)	FALSE	SW-1	Staubli	Staubli	
prm06	air supply - pressure reference, west discharge chamber	WD-2	WD2	3/8	C	IA-2	0.2	scfh	1	psig	113 (45)	1	scfh	150	psig	150 (66)	FALSE	SW-1	Staubli	N/A	
tmp01	TC - east discharge assembly #1	N/A	tmp01	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	EDT	Lemo	Lemo	
tmp02	TC - east discharge assembly #2	N/A	tmp02	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	EDT	Lemo	Lemo	
tmp03	TC - glass pool/plenum assembly #01	WB-1	tmp03	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp04	TC - glass pool/plenum assembly #10	CB-10	tmp04	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp05	TC - glass pool/plenum assembly #11	CB-11	tmp05	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp06	TC - glass pool/plenum assembly #12	CB-12	tmp06	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp07	TC - glass pool/plenum assembly #13	CB-13	tmp07	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp08	TC - glass pool/plenum assembly #14	EB-14	tmp08	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp09	TC - glass pool/plenum assembly #16	EB-16	tmp09	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp10	TC - glass pool/plenum assembly #17	EB-17	tmp10	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp11	TC - glass pool/plenum assembly #18	EB-18	tmp11	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp12	TC - glass pool/plenum assembly #02	WB-2	tmp12	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp13	TC - glass pool/plenum assembly #03	WB-3	tmp13	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp14	TC - glass pool/plenum assembly #04	WB-4	tmp14	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
tmp15	TC - glass pool/plenum assembly #05	WB-5	tmp15	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp16	TC - glass pool/plenum assembly #06	CB-6	tmp16	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp17	TC - glass pool/plenum assembly #07	CB-7	tmp17	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp18	TC - glass pool/plenum assembly #08	CB-8	tmp18	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	
tmp19	TC - glass pool/plenum assembly #09	CB-3	tmp19	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp20	TC - refractory	CT-1	CT-1	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp21	TC - startup #1	CS-3	CS3	N/A	C/U	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	6
tmp22	TC - startup #2	CS-6	CS6	N/A	C/U	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LWT	Lemo	Lemo	6
tmp23	TC - west discharge #1	N/A	tmp23	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WDT	Lemo	Lemo	
tmp24	TC - west discharge #2	N/A	tmp24	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WDT	Lemo	Lemo	
tmp25	TC - glass pool/plenum assembly #15	EB-15	tmp25	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	LET	Lemo	Lemo	
tmp26	T/C - east discharge auxiliary heater	N/A	tmp26	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	EDT	Lemo	N/A	
tmp27	T/C - west discharge auxiliary heater	N/A	tmp27	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WDT	Lemo	N/A	
vew01	air supply - cctv cooling, northwest plenum	WV-2	WV2	3/8	C	IA-2	10	scfm	5	psig	113 (45)	20	scfm	5	psig	150 (66)	TRUE	WN-2	Staubli	Staubli	
vew02	power - cctv, northwest plenum	N/A	vew02	N/A	C	E	1	A	24	V	N/A	1	A	120	V	N/A	FALSE	WNE	Lemo	Lemo	
vew03	air supply - cctv purge, northwest plenum	WV-1	WV1	3/4	C	IA-2	17	scfm	5	psig	113 (45)	20	scfm	15	psig	150 (66)	FALSE	WN-2	Staubli	Staubli	
vew04	signal - cctv, northwest plenum	N/A	vew04	N/A	C	E	note		1	V	N/A	N/A		N/A		N/A	FALSE	WNE	Lemo	Lemo	57
vew05	air supply - cctv cooling, northeast plenum	EV-2	EV2	3/8	C	IA-2	10	scfm	5	psig	113 (45)	20	scfm	5	psig	150 (66)	TRUE	EN-2	Staubli	Staubli	
vew06	power - cctv, northeast plenum	N/A	vew06	N/A	C	E	1	A	24	V	N/A	1	A	120	V	N/A	FALSE	ENE	Lemo	Lemo	
vew07	air supply - cctv purge, northeast plenum	EV-1	EV1	3/4	C	IA-2	17	scfm	5	psig	113 (45)	20	scfm	15	psig	150 (66)	FALSE	EN-2	Staubli	Staubli	
vew08	signal - cctv, northeast plenum	N/A	vew08	N/A	C	E	note		1	V	N/A	N/A		N/A		N/A	FALSE	ENE	Lemo	Lemo	57
vew09	air supply - cctv cooling, southwest plenum	WV-4	WV4	3/8	C	IA-2	10	scfm	5	psig	113 (45)	20	scfm	5	psig	150 (66)	TRUE	WS-2	Staubli	Staubli	
vew10	power - cctv, southwest plenum	N/A	vew10	N/A	C	E	1	A	24	V	N/A	1	A	120	V	N/A	FALSE	WSE	Lemo	Lemo	
vew11	air supply - cctv purge, southwest plenum	WV-3	WV3	3/4	C	IA-2	17	scfm	5	psig	113 (45)	20	scfm	15	psig	150 (66)	FALSE	WS-2	Staubli	Staubli	
vew12	signal - cctv, southwest plenum	N/A	vew12	N/A	C	E	note		1	V	N/A	N/A		N/A		N/A	FALSE	WSE	Lemo	Lemo	57
vew13	air supply - cctv cooling, southeast plenum	EV-4	EV4	3/8	C	IA-2	10	scfm	5	psig	113 (45)	20	scfm	5	psig	150 (66)	TRUE	ES-2	Staubli	Staubli	
vew14	power - cctv, southeast plenum	N/A	vew14	N/A	C	E	1	A	24	V	N/A	1	A	120	V	N/A	FALSE	ESE	Lemo	Lemo	
vew15	air supply - cctv purge, southeast plenum	EV-3	EV3	3/4	C	IA-2	17	scfm	5	psig	113 (45)	20	scfm	15	psig	150 (66)	FALSE	ES-2	Staubli	Staubli	
vew16	signal - cctv, southeast plenum	N/A	vew16	N/A	C	E	note		1	V	N/A	N/A		N/A		N/A	FALSE	ESE	Lemo	Lemo	57

Tag	Description	Temp Conn ID	Melter Nozzle Tag	Line/ Wire Size (in)	Ops Mode (13)	Service Type (12)	Nominal Flow/Amp	Nom F/A Unit	Nominal Pres/Volt	Nom P/V Unit	Nom Temp F (C)	Design Flow/Amp	Des F/A Unit	Design Pres/Volt	Des P/V Unit	Des Temp F (C)	Critical Srvc	Connect Box Number	Externl Style (10)	Internal Style	Notes
vew17	power - cctv purge air heater, northwest	N/A	vew17	#10	C	E	27.3	A	220	V	N/A	27.3	A	220	V	N/A	FALSE	WNE	Lemo	Lemo	
vew18	TC - northwest cctv purge heater temperature	N/A	vew18	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WNE	Lemo	Lemo	
vew19	TC - northeast cctv purge heater temperature	N/A	vew19	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ENE	Lemo	Lemo	
vew20	power - cctv purge air heater, southwest	N/A	vew20	#10	C	E	27.3	A	220	V	N/A	27.3	A	220	V	N/A	FALSE	WSE	Lemo	Lemo	
vew21	TC - southwest cctv purge heater temperature	N/A	vew21	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	WSE	Lemo	Lemo	
vew22	power - cctv purge air heater, southeast	N/A	vew22	#10	C	E	27.3	A	220	V	N/A	27.3	A	220	V	N/A	FALSE	ESE	Lemo	Lemo	
vew23	TC - southeast cctv purge heater temperature	N/A	vew23	N/A	C	TC	N/A		N/A		N/A	N/A		N/A		N/A	FALSE	ESE	Lemo	Lemo	
vew24	power - cctv purge air heater, northeast	N/A	vew24	#10	C	E	27.3	A	220	V	N/A	27.3	A	220	V	N/A	FALSE	ENE	Lemo	Lemo	
vew25	air supply - west discharge, west air knife	lower	vew25																		38
vew26	air supply - east discharge, east air knife	lower	vew26																		38
vew27	air supply - east discharge, west air knife	upper	vew27																		38
vew28	air supply - west discharge, east air knife	upper	vew28																		38
vew29	air supply - gamma detector cooling, west seal head	N/A	vew29																		38
vew30	air supply - gamma detector cooling, east seal head	N/A	vew30																		38
vew31	air supply - cctv purge, west discharge pour stream	N/A	vew31																		38
vew32	air supply - cctv cooling, west discharge pour stream	N/A	vew32																		38
vew33	air supply - cctv purge, west seal head	N/A	vew33																		38
vew34	air supply - cctv cooling, west seal head	N/A	vew34																		38
vew35	air supply - ir cctv cooling, west seal head	N/A	vew35																		38
vew36	air supply - ir cctv purge, west seal head	N/A	vew36																		38
vew37	air supply - cctv purge, east discharge pour stream	N/A	vew37																		38
vew38	air supply - cctv cooling, east discharge pour stream	N/A	vew38																		38
vew39	air supply - cctv purge, east seal head	N/A	vew39																		38
vew40	air supply - cctv cooling, east seal head	N/A	vew40																		38
vew41	air supply - ir cctv cooling, east seal head	N/A	vew41																		38
vew42	air supply - ir cctv purge, east seal head	N/A	vew42																		38
vnt01	vent - west discharge lid return to plenum	W03	W03	2	C	OG	58	scfm	-5	in wc	932 (500)	58	scfm	+10/-40	in wc	1112 (600)	FALSE	N/A	N/A	Graylok	
vnt04	vent - annular space contamination control, exhaust	N/A	vnt04	12 x 17	C	Vent	1360	scfm	-2	in wc	59-113 (15-45)	1500	scfm	-2	in wc	59-113 (15-45)	FALSE	N/A	Cutsom 12 x 17 flange with bolts. See WTP-M-11751-14	N/A	18
vnt05	vent - annular space contamination control, supply	N/A	vnt05	12 x 17	C	Vent	1500	scfm	-2	in wc	59-113 (15-45)	1500	scfm	-2	in wc	50-113 (15-45)	FALSE	N/A	Cutsom 12 x 17 flange with bolts. See WTP-M-11751-14	N/A	18

Notes (numbers not shown have been deleted and are not referenced in the table):

1	Cooling water supply temperature is to be greater than melter gallery air temp to prevent condensation.
6	Installed only during melter startup
10	See assembly drawings for connector details and part numbers.
11	Discharge chamber auxiliary heaters not normally connected. Heater to be used for pour flange glass blockage recovery only.
12	Nominal return temperature for normal feeding mode late in melter life with 50% glass contact refractory loss, range for all 5 PFD operating modes in parenthesis.
13	Nominal return temperature for normal melter idling mode.
14	Air lift discharges are operated intermittently one at a time. Argon is purged through the air lift at 0.2 SCFH when glass is not being discharged.
18	Shielded lid and wall module contamination control air exhausts are combined as "shield vent" exhaust air. vnt05 comes from wet process cell, vnt04 goes to C5 exh
19	See list below for description of service types and associated service qualities.
24	N/A = Not Applicable
27	Attached to standby offgas port.
28	Cooling air will be exhausted into the melter cave
29	Bubbler and start-up heaters fit same lid nozzles
30	Frit addition and feed nozzles fit same lid nozzles
33	Maximum temperature
35	May include water flush for film cooler
36	Included in pressure control air injection
37	Temperature may be higher if film cooler and air injection stops during pressure trip
38	Data is determined by Bechtel and defined in other design documents.
39	Routing of air injection may be through the melter lid in which case it is an interface. If it is conncted to the off-gas jumper its is not an interface.
40	Seal pot or trap required
44	Temperatures assume 50 scfm cooling to side electrodes, 50 scfm to bottom electrode if cooled (bottom electrode normally not cooled), and 10 scfm cooling for side and bottom electrode extensions.
45	Design pressures based on maximum system pressures developed in the IA system, will need to get from SD or contractor P&ID (Project Reference)
48	Design temperature of the pipe/connection, with the potential for water to boil to create steam
49	Based on strict definition of B31.3. The cooling water system is "suspect radioactive" and may require more rigorous fabrication and inspection requirements.
50	Once every four hours the feed lines are flushed - once through. This occurs for each of the six ADS pumps/feedlines or 1.5gph per melter.
51	Startup from idle, once through water (for 30 min. use w/ 2 nozzles), use about once per month per melter (this is a guess based on bubbler replacement schedule)
52	Air flows during pours only, approximately 1 hour every 3 hours. Argon used as a continuous purge, even during pours (about 1 scfh).
53	Air flows during pours only, approximately 30 minutes every 3 hours. Argon used as a continuous purge, even during pours (about 1scfh).
54	Water used to "cool" plenum after an idle condition. Flow from only 1 nozzle required, duration approximately 30 minutes.

55 Signal is digital. RS 485 or 232.
57 Video signal format is "S-Video".
58 Criteria for this service defined by contractor, not subcontractor.
60 This is not a design interface between the contractor and subcontractor.

62 Vendor product shown is prefered. However, a contractor-approved equal may be acceptable.
63 See subcontractor assembly drawings for precise locations. Locations shown are for quick reference on the connections deemed the most critical.

64 Process values are based on pilot melter data and design development by subcontractor. Actual melter operating/design criteria may vary based on final services system design by project
65 Service connection with no "CONN ID" were not given a unique tag number by the subcontractor.
66 This critical service can be halted long enough to change the supply source.
67 This critical service can be halted for a maximum of 3 hrs before irreparable damage may occur.
68 Not considered a critical service. However, loss of air may result in component failure after roughly 8-12 hours.

Operations Modes:

C	Continuous
C/U	Continuous if used
I	Intermittent and likely use
Rare	Not used except under special conditions or very infrequently

Service Types:

Ar	Argon. Welding grade
CW-1	Cooling Water. Demineralized, filtered <2 microns, biocide additions allowed, no corrosion inhibitors, chlorides <40 ppm, sulfate <100ppm, TDS <340ppm, TSS <300ppm, total hardness <170ppm
CW-2	Cooling Water. Same as CW-1 except for having a specific conductivity <200 micromhos/cm.
DR	Drain
E	Electrical
Feed	Melter Feed
IA-1	Instrument Air. Per ANSI/ISA-S7.0.01-1996.
IA-2	Instrument Air. Same as IA-1 with final point-of-use filter to remove water, particulate, aerosols, and reduce total hydrocarbon content to <1ppm v/v methane basis.
LS	Limit Switch
M	Mechanical
OG	Off-Gas
PA	Plant Service Air. Oil free, dew point 33-39F, filter to 2 microns.
PW	Process Water. Raw river water filtered to 2 microns. Recommend analysis for various times of the year be reviewed so dissolved species contents are known.
TC	Thermocouple
Vent	C5 Ventilation.

Appendix B- Melter Design Interface Details

Melter Engineering Specification Appendix Note:

The data in this appendix are based on experience from pilot melters and other operating units. This data was gathered early in the project and used as a guide for design of surrounding utilities. The values should not be used directly as input since in many cases the design has continued to evolve and there may be inconsistencies between issued design documents and values in these tables. Instead, refer to the appropriate design media, e.g. P&IDs, melter design drawings, melter design calculations, or other system calculations. These data may be used as an assumption for performing calculations but the assumption will require verification by the calculation where it was used or other design media.

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
enc65	access panel - cooling water	weight of component	170 lb maximum	LSH	several cooling panel covers exist, the maximum value is used
enc63	access panel - discharge chamber shielded lid	weight of component	1020 lb approximate	LSH	
enc64	access panel - electrode bus	weight of component	100 lb maximum	LSH	several electrode panels exist, the maximum value is used
enc62	access panel - offgas, film cooler, primary and standby	weight of component	1000 lb approximate	LSH	
enc68	access panel - shielded lid large port	weight of component	175 lb approximate	LSH	
agi11	access panel - shielded lid large port (including bubblers)	shielded lid interface detail with project replacement equipment	dowel pins 1.5" dia. - 6UNC, spacing and hole locations per the project reference drawings, alignment via two, 3/8" alignment rods 175 degrees apart to match the CCB, gamma gate (exception - bubbler port EB18 has 2, 1-1/4" - 7 UNC)	LSH	
enc69	access panel - shielded lid small port	weight of component	20 lb approximate	LSH	
enc67	access panel - shielded lid vent cover	weight of component	210 lb approximate	LSH	
enc66	access panel -jack bolt (maximum)	weight of component	160 lb approximate	LSH	several jack bolt cover sizes exist, the maximum value is used
enc41	access panels- feed line junction box	weight of component	75 lb approximate	LSH	
agi13	bubbler	dimensions - envelope	20" dia. X 117" long	LSH	length from bottom of bubbler to top of cover (106.5") plus length of ball lock on top of cover plate (6")
agi03	bubbler	maintenance handling criteria	Bubbler to be replaced via CCB/gamma gate after manually unplugging thermocouple. Use of ball lock assembly to match CCB device. Air to be supplied continuously during insertion into melt pool.	LSH	required to meet the bubbler orientation established in agi12. Glass contact consumable
agi02	bubbler	operating life (predicted)	6 months (incl. thermocouples)	LSH	
agi12	bubbler	orientation	E-W direction, 180 degrees apart	LSH	
agi09	bubbler	shielded lid inner guide tube inside diameter	20.5" I. D.	LSH	
agi10	bubbler	shielded lid large port counter bore inner diameter	21.5" I. D. at 1/2" depth	LSH	
agi07	bubbler	weight of component	760 lb approximate	LSH	Bubbler weight provided without addition of air cylinder and subsequent equipment
vew07	cctv - for melter plenum	dimensions - envelope	14" dia. X 36" long	LSH	
vew03	cctv - for melter plenum	maintenance handling criteria	CCTV and view port to be independently replaceable (non-routine). Maintenance to be hands-on.	LSH	no specific lifting features incorporated into the design

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
vew02	cctv - for melter plenum	operating life (predicted)	life of melter	LSH	
vew09	cctv - for melter plenum	weight of component	85 lb approximate	LSH	
enc55	consumables	weight of component	650 lb (maximum - for melter lid components only, excluding film cooler assemblies)	LSH	
enc56	consumables	dimensions - maximum (lid components only, excluding film cooler assemblies)	20" dia. X 125" long	LSH	Maximum envelope dimensions imposed on Duratek consumable design to accommodate project replacement equipment for lid components only (excluding film cooler assemblies). Based on a 1/4" radial clearance
fed28	consumables - small consumables	shielded lid inner guide tube counter bore	8.5" I.D. at 1/2" depth	LSH	includes feed nozzles, level detector, pressure probe (ITS), glass riser air lift lance, spare plugs, refractory thermowell/thermocouple, startup thermowell/thermocouple
fed27	consumables - small consumables	shielded lid inner guide tube inside diameter	7.5" I.D.	LSH	see fed28, dimension taken from the feed line nozzle, same dimension for all other small consumables
enc24	datum point - melter reference	melter datum point - description of physical location (x,y,z location from which all melter dimensions originate from)	centerline of the melter north-west seismic pin, top of rail, physical dimensions from column lines shown on project drawing reference	20	
enc92	discharge chamber	shielding thickness requirements	enclosure plate thickness (including penetration access panels) on all external faces of melter discharge chambers shall be a minimum of 2 inches.		
enc59	discharge chamber lid	maintenance handling criteria	a changeout box, built exclusively for the discharge chamber consumables, will be provided by contractor. Part of the weight of the changeout box will rest on the melter shielded lid. The vertical distance from top of the discharge chamber shielded lid to the melter shielded lid is 36.75"	LSH	
por39	discharge chamber lid with heaters	dimensions - envelope	42" (N-S) X 32.5" (E-W) X 80" high	LSH	height includes the lifting bail
por06	discharge chamber lid with heaters	maintenance handling criteria	four pick points, one on each corner of the lid	LSH	definition of specialty lifting equipment unknown, issues with guides and other equipment not resolved
por05	discharge chamber lid with heaters	operating life (predicted)	life of melter	LSH	based on continuous heater operation
por41	discharge chamber lid with heaters	weight of component	1170 lb approximate	LSH	
por110	discharge chamber pressure probe - lid plug, 4"	dimensions - envelope	7" dia. X 26.15" long	LSH	length does not include the wire rope lifting bail, lid plug used to measure the pressure in the discharge chamber
env85	discharge chamber shielded cover plate	maintenance handling criteria	4 pick points (folding bails) one in each corner	LSH	

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
ogs53	discharge chamber vent insert	dimensions - envelope	7" dia. X 72.5" long	LSH	
ogs51	discharge chamber vent insert	maintenance handling criteria	vertical lift with overhead device, lifting bail on component after removal of vent line	LSH	
ogs50	discharge chamber vent insert	operating life (predicted)	life of melter	LSH	
ogs52	discharge chamber vent insert	weight of component	70 lb approximate	LSH	
ogs57	discharge chamber vent line	dimensions - envelope	discharge chamber section - 28" X 16" X 12", middle section - 48" X 12" X 12", lid section - 36" X 18" X 12"	LSH	dimension does not include the lifting bail
ogs54	discharge chamber vent line	operating life (predicted)	life of melter	LSH	
ogs56	discharge chamber vent line	weight of component	discharge chamber section - 62 lb, middle section - 55 lb, lid section - 48 lb (all approximate weights)	LSH	
ogs55	discharge chamber vent line - discharge chamber section, middle section, plenum section	maintenance handling criteria	welded lug attachments to accommodate overhead lifting device	LSH	vent line sections attached with graylok flanges
enc61	discharge chamber, shielded lid	shielded lid interface detail with project replacement equipment	dowel pins 1.5" dia. - 6 UNC, spacing and hole locations per the project reference drawings	LSH	restraint point locations on the shielded lid for the discharge chamber CCB, support provided by the shielded lid
enc49	drain for annulus space	location from datum	center of flange, raised face from datum: gas barrier - 137.76"E, 8.15" S, 15.81" up; annular space - 115.51"E, 8.15"S, 15.81" up	RLD	
env56	facility rails	centerline to centerline dimension	28'-4"	LMH	
env54	facility rails	deflection limits - maximum wheel travel	0.0625" - combined deflection and surface discontinuities	LMH	
env55	facility rails	finish/coating/heat treating/physical properties	Alloy steel 4340 (100 ksi yield) head hardened, 55-60 Rc	LMH	
env59	facility rails	maximum rail gap	1/4"	LMH	
env60	facility rails	size	rail height - 3'-11.125" elevation, rail width - 6"	LMH	
env61	facility rails	tolerance, straightness	rails shall be straight to within 0.040" per 16' of rail length in both directions	LMH	
fed12	feed nozzle	dimensions - envelope	7.5" dia. X 68.65" long	LSH	envelope length includes ball lock lifting assembly, envelope diameter includes the tadpole gasket (.25" dia.)
fed08	feed nozzle	maintenance handling criteria	ball lock assembly, 1" diameter, 4-ball	LSH	equipment used for removal determined by project, this component is not a glass contact item
fed07	feed nozzle	operating life (predicted)	life of melter	LSH	water cooled feed nozzle
fed16	feed nozzle	weight of component	149 lb approximate	LSH	
fed19	feed nozzle - glass frit addition	dimensions - envelope	12" dia. X 78" long	LSH	length does not include the lifting bail , diameter does not include the valve

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
fed22	feed nozzle - glass frit addition	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	equipment used for removal determined by project, this component is not a glass contact item
fed03	feed nozzle - glass frit addition	operating life (predicted)	temporary component, can be re-used since it is not exposed to radioactive material	LSH	
fed21	feed nozzle - glass frit addition	weight of component	110 lb approximate	LSH	
ogs13	film cooler - primary and standby	dimensions - envelope	28" X 50" X 64"	LSH	
ogs65	film cooler - primary and standby	maintenance handling criteria	non-routine maintenance activity, use of temporary rigging and strapping methods	LSH	
ogs03	film cooler - primary and standby	operating life (predicted)	life of melter	LSH	based on proper operation of the spray nozzles
ogs15	film cooler - primary and standby	weight of component	1300 lb approximate	LSH	weight includes transition piece, film cooler, wash nozzle, and bellows assembly. Will replace entire assembly rather than individual components
ogs66	film cooler - standby	functional requirements	1) keep port clean during slurry feeding so it is available to ventilate gases in upset. 2) provide cooling air for bypass idling.	LMP/LOP	
ogs47	film cooler - transition piece	maintenance handling criteria	non-routine maintenance activity, use of temporary rigging and strapping methods	LSH	transition piece to be replaced with the film cooler (one unit) if necessary. Life of melter component. Considered non-routine maintenance activity.
ogs46	film cooler - transition piece	operating life (predicted)	life of melter	LSH	
ogs17	film cooler cleaner	dimensions - envelope	4' X 4' X 15' high	LSH	
ogs08	film cooler cleaner	maintenance handling criteria	to be verified after completion of actual melter design	LSH	film cooler cleaner to be installed above the film cooler after removal of the water spray nozzle. Cleaner is only to be installed if persistent clogging cannot be resolved by other methods.
ogs07	film cooler cleaner	operating life (predicted)	temporary component, used only when film cooler is blocked	LSH	installed to the film cooler only if necessary
ogs19	film cooler cleaner	weight of component	less than 5500 lb	LSH	
ogs45	film cooler spray nozzle	dimensions - envelope	10.12" dia. X 49" long, excludes pipe elbows on the top flange	LSH	envelope diameter includes 1" long shoulder screws to attach the lifting bail, actual flange diameter is 8.12". Pipe elbows are excluded from the overall assembly length
ogs43	film cooler spray nozzle	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	
ogs42	film cooler spray nozzle	operating life (predicted)	12 months	LSH	
ogs44	film cooler spray nozzle	weight of component	150 lb maximum	LSH	
plv07	glass pool level detector/density probe/primary pressure probe	dimensions - envelope	7.5" dia. X 122.12" long	LSH	includes glass level detector, density probe and primary pressure probe in one consumable assembly. Length includes the ball lock lifting assembly, envelope diameter includes the tadpole gasket (.25" thick)

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
plv03	glass pool level detector/density probe/primary pressure probe	maintenance handling criteria	ball lock assembly, 1" diameter, 4-ball, project to utilize CCB/gamma gate for replacement	LSH	includes glass level detector, density probe and primary pressure probe in one consumable assembly. Equipment used for removal to be determined by project. This component is glass contacting
plv02	glass pool level detector/density probe/primary pressure probe	operating life (predicted)	12 months	LSH	includes glass level detector, density probe and primary pressure probe in one consumable assembly
plv09	glass pool level detector/density probe/primary pressure probe	weight of component	131 lb approximate	LSH	includes glass level detector, density probe and primary pressure probe in one consumable assembly
por48	glass riser airlift lance	dimensions - envelope	6.9" dia. X 109 " long	LSH	envelope diameter includes the tadpole gasket (.25" thick), envelope length includes ball lock assembly and ball lock support structure.
por12	glass riser airlift lance	maintenance handling criteria	ball lock assembly, 1" diameter, 4-ball, project to utilize CCB/gamma gate for replacement	LSH	Equipment used for removal to be determined by project. This component is glass contacting
por96	glass riser airlift lance	operating life (predicted)	life of melter	LSH	
por50	glass riser airlift lance	weight of component	110 lb approximate	LSH	
por112	lid plug, 4", discharge chamber	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	device used to monitor pressure within the discharge chamber. Not a glass contact component
por111	lid plug, 4", discharge chamber pressure probe	weight of component	40 lb approximate	LSH	lid plug used for measuring the pressure in the discharge chamber
por97	lid plug, 6", discharge chamber	dimensions - envelope	8.25" dia. X 30 " long	LSH	envelope length includes the wire rope lifting bail, plug to be used for inserting camera if necessary
por99	lid plug, 6", discharge chamber	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	device used as a spare port for insertion of camera if necessary, not a glass contact component
por98	lid plug, 6", discharge chamber	weight of component	73 lb approximate	LSH	
env86	lifting bails	jackbolt cover plates	threaded insert for eye bolt	LSH	this is typical for the jack bolt covers
env35	lifting lugs on melter shell	configuration	lifting lugs (10) to be located on melter base on each end at the wheel support assemblies (5 per side).	LMP/LMH	
enc91	melter - enclosure	shielding thickness requirements	enclosure plate thickness (including penetration access panels) on all external faces of the melter shall be a minimum of 1 inch, except for the top surface plates directly above the film coolers, which shall be a minimum of 2 inches. The thicker plate above the film coolers shall extend a minimum of 1 foot from the centerline of the film coolers in all directions.		
env28	melter - general	castable refractory - allowable sit times before bakeout	1 year minimum with green castables	LMP	

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
env21	melter - general	center of gravity	empty melter, W - 170", S - 116", Up - 82"; glass-filled melter, W - 170", S - 116", Up - 81"; grouted melter, W - 170", S - 114", Up - 95"	LMP/LMH	all dimensions with respect to the centerline of the east seismic pin at the top of the rail. (W - west, S - south)
gls10	melter - general	corrosion rate limits - refractory	<1.0 in/yr of K-3, measured at refractory coupon half down coupon at ~1200°C by the modified ASTM C621 method	LMP	
env22	melter - general	dimensions - envelope	262" long X 367" wide X 190" high	LMP/LMH	overall melter dimensions when the melter is in its final location, includes the seismic restraints, bus bars, and discharge chambers.
env19	melter - general	external loads induced on melter shell and structure	feed lines (slurry) routed in enclosure (tray) to be mounted to the face of the melter shield at north-east corner.	LMP/LFP	
enc19	melter - general	use of common nozzles between operating modes	spare exterior small ports used for frit addition, spare interior small ports used for startup thermocouples, bubbler ports used for start-up heaters during melter start-up	LMP	
env01	melter - general	weight of melter	empty - 594,319 lb; max glass level - 632,819 lb; grouted - 953,927 lb (all approximate)	LMH	
mab01	melter - general	welding of melter lid to melter wall modules	approximate: C-276 or alloy 690 - 110' seam weld 1/8" fillets (non-structural); A36 - 200' full pen welds 1" base metal; A36 - 45' 1/4" fillet weld on 1/4" base metal; A36 to SS (300 series) 200' fillet welds up to 1/4"	LMP	
env93	melter - lid	lifting/flipping attachment configuration	lifting lugs attached to lid suitable for flipping	LMH	
env92	melter - lid	lifting/flipping criteria	lid must be designed to be flipped 180 degrees after castable refractory is installed without damage to refractory.	LMH	based on the castables formed and poured with the lid flipped 180 degrees
env94	melter - lid	lifting/flipping loads	Lifting lug design and lifting and handling methods must comply with WTP site rigging and handling requirements.	LMH	
enc18	melter - lid	number and sizes of spare ports	8 spare ports (6" dia.) provided on the lid.	LMP	5 ports for refractory viewing, 2 ports for start up thermocouples, 1 port for spare pressure indicator with utilities. TQ-143 identifies 9 spare ports but one of these (WS-1) will be utilized for the ITS pressure probe
env95	melter - lid	top surface elevation	19'-9"	LMH	
vnt04	melter - operation	C5 ventilation system supply air flow during normal operations (see comments)	1500 ACFM	C5V	air flow only required for contamination control. Normal operations defined as start up, feeding, pouring, and idle melter conditions
gls01	DELETED				
gls07	DELETED				

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
gls11	DELETED				
gls13	DELETED				
por42	DELETED				
htg26	DELETED				
gls16	DELETED				
ogs62	melter - operation	injection gases to primary film cooler during idling, (normal mode)	30-50 scfm (cold) air	LMP/PSA	
ogs63	melter - operation	injection gases to primary film cooler during slurry feeding	steam flow =200 kg/h; air flow =325 kg/h. Mixed gas shall be conditioned to avoid condensed water. Maximum mixed gas volume = 450 ACFM, approx. 150°C	LMP/PSA/SCW	
ogs64	melter - operation	injection gases to standby film cooler during slurry feeding, idling, bypass idling	air only: 30-50 scfm (cold air) during slurry feeding and idling; 100-150 scfm (cold air) during idling bypass mode.	LMP/PSA	
ogs30	melter - operation	offgas airflow - nominal airflow downstream of film cooler	1056 acfm @ 315 deg C	LOP	airflow for worst case envelope C
ogs28	melter - operation	offgas airflow - nominal airflow upstream of film cooler	760 scfm @ 400 deg C	LOP	worst case with envelope C
ogs41	melter - operation	offgas in-leakage	289 scfm at -5" w.c. for new melter	LOP/C5V	
ogs21	DELETED				
ogs23	melter - operation	offgas temperature in plenum - during idle conditions	~2100°F (1150°C) nominal	LOP	this is the glass temperature at idle conditions
ogs22	melter - operation	offgas temperature in plenum - normal feeding operations - before film cooler	752°F (400°C) nominal	LOP	plenum temperature, off-gas entering film cooler
tmp03	melter - operation	temperature of melter lid surface (maximum)	95°F. Small surface areas (less than 2' square) immediately above the film coolers that exceed 95°F are acceptable.	LSH	
tmp04	melter - operation	temperature of melter surfaces other than lid (maximum)	140°F, except the discharge chamber lid which is at 210°F (maximum)	LSH	
vnt08	melter - operation	ventilation - air in-leakage from gallery into melter annular spaces	none - access ports are provided with seals	C3V/C5V	
vnt11	melter - operation	ventilation - air in-leakage from melter annular spaces into plenum	296 ACFM, 254 SCFM	C5V/LOP	
vnt03	melter - operation	ventilation - airflow face velocity through penetrations	200 linear feet per minute - minimum	C3V/C5V	
vnt01	melter - operation	ventilation - melter annular space ventilation criteria	sufficient air extraction rate to maintain inflow rate requirement of VNT03 while a single shielded lid plug is removed (bubbler, etc). Discharge heater or film cooler replacement (non-routine maintenance) require temporary containment. This criteria does not apply during startup for jack-bolt panels.	C5V	to maintain sufficient face velocity (200 fpm) across the melter shielded lid openings during maintenance activities
vnt22	melter - operation	ventilation system (C5) exhaust air flow during normal operations (see comments)	1200 ACFM exhaust flow, 1500 ACFM supply to melter annulus	C5V	air flow only required for contamination control. Normal Operations defined as start up, feeding, pouring, and idle melter conditions

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
vnt06	melter - operation	ventilation system (C5) exhaust air flow during other modes w/high demands	1893 ACFM; 1060 SCFM	C5V	air flow only required for contamination control. Based on offgas failure case noted in the reference
vnt10	melter - operation	ventilation system (C5) exhaust air flow from panel removal/ component changeout	1606 SCFM, 1676 ACFM	C5V	air flow only required for contamination control. Based on an opening size of 1400 in^2
res02	melter - seismic	loads on seismic restraints	176,162 lbs. For the N-S and E-W direction, total load each direction, includes 10% contingency	20	Seismic loads developed in melter must be conveyed to project for design of building restraints
res03	melter - seismic	location of seismic restraints	N-S seismic restraints to be located on the north end of the melter wheel trucks (total of 2 locations). E-W seismic restraints located along wheel trucks between wheels (total of 10 locations).	LMH	Seismic
res04	melter - seismic	quantity of seismic restraints	total of 12; 10 east-west, 2 north-south	LMH	
enc90	melter - seismic	seismic restraint bracket envelope	E-W seismic restraints clamp to outside of rails, and accommodate maximum thermal growth between rails of 0.25". N-S seismic restraint brackets are pinned to rail at 15'-5.68" from building grid F on rail centerlines. Shim packs will be used to hold the north face of the wheel truck assembly nominally 8"south of the pin centerline. Bracket shall allow for maximum of +1/2" adjustment from nominal dimension.	LMH	
res01	melter - seismic	seismic restraint interface configuration	N-S: pin in rail through slotted hole in bracket on north end of melter truck. Bracket is attached (on east side replaces guide roller bracket) once melter is rolled into place. Gap between end truck and bracket is filled with shims and bolts are tightened. E-W: Belleville Spring-loaded clamps on rails are fitted to melter chassis after melter is in position and tightened after final N-S position is fixed.;	LMH	
res08	melter - seismic	seismic restraint N-S pin size	3.5" X 3.5" square pin, utilize a 4.5" slotted hole. Pin projection above rail 2 7/8".	LMH	pin size and shape changed from 3" diameter to 3.5" square configuration
env38	melter - transport	clearance criteria for transport through facility	8" minimum under the melter, 2" minimum clearance under the melter transport pulley assembly	LMH	
env43	melter - transport	max allowable acceleration/ deceleration x/y/z (new melter only)	0.1 g	LMH	
env44	melter - transport	max relative vertical racking during transport (new melter only)	1/16 inch (corner to corner)	LMH	
env87	melter - transport	maximum melter width dimension for transport through facility, i.e.- door clearance	358.5"	LMH	Maximum dimension includes guide rollers, does not include seismic restraints. Seismic restraints installed when melter is in place.
env29	melter - transport	melter drive system - attached loads for pulling melter	43,000 lbs.	LMH	actual load is 41,152 lbs. Weight used bounds the actual weight
env30	melter - transport	melter drive system attachment interface to melter	pulleys/brackets with removable connections. Pulley centerline elevation at 3'-5" elevation connected to the melter base. Two pulleys in the front and the back located 102.88" in from the respective rail centerline	LMH	

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
env31	melter - transport	melter drive system positioning tolerance in facility (north-south)	plus, minus 1/4"	LMH	
env50	melter - transport	transporter load distribution criteria	two linear pads, 300 inches apart (outside edges) tolerance +0.00"/-0.50", width not to exceed 12" (6" nominal), thickness between 1" and 2"	LMH	Required to spread the transport load as close to the wheels as possible to avoid reverse deflection of the refractory. Design requirement for the melter and the project transporter.
env51	melter - transport	transporter rigging criteria	hold down lugs attached to the melter base are not required	LMH	
enc44	piping - all nozzles except for offgas	thermal movement (maximum) of any nozzle, from centroid of melter	+/- 1"	LMP	
clg03	piping - cooling water	cooling panel/pipe pressure differential	15 psig per loop, maximum differential	PCW	pressure drop across panel must be minimized
clg02	piping - cooling water	slope	no slope required. Panels to be emptied through air "blow-down".	PCW	
fed18	piping - feed	attachment to melter	the melter feed line will be routed in a secondary enclosure (tray), tray attached to melter wall with a sealed connection	LFP	
enc45	piping - offgas nozzles	thermal movement from centroid of melter	+/- 1/2"	LMP	
ogs61	plenum vent insert	dimensions - envelope	11.5" diameter X 36" long	LSH	
ogs59	plenum vent insert	maintenance handling criteria	vertical lift with overhead device, lifting bail on component after removal of vent line	LSH	
ogs58	plenum vent insert	operating life (predicted)	life of melter	LSH	discharge chamber vent system to plenum
ogs60	plenum vent insert	weight of component	70 lb approximate	LSH	
plv18	pressure probe - primary (ITS)	dimensions - envelope	7.5" dia. X 52" long	LSH	
plv16	pressure probe - primary (ITS)	maintenance handling criteria	ball lock assembly to mate with project reference drawings, project to utilize CCB/gamma gate for replacement	LSH	
plv15	pressure probe - primary (ITS)	operating life (predicted)	12 months	LSH	
plv17	pressure probe - primary (ITS)	weight of component	130 lb maximum	LSH	
enc58	shielded lid access covers	maintenance handling criteria	folding bail, inset to preclude tripping hazards (flush with top surface)	LSH	
enc60	small diameter holes, shielded lid (feed nozzles, air lift lances, refractory thermocouple, level detectors, ITS pressure probe, spare plugs, start up ports)	shielded lid interface detail with project replacement equipment	dowel pins 1" dia. - 8 UNC, spacing and hole locations per the project reference drawings	LSH	
enc54	spare lid plug - small	dimensions - envelope	7.5" dia. X 36.37" long	LSH	envelope diameter includes the tadpole gasket (.25" thick), envelope length includes the ball lock assembly

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
enc52	spare lid plug - small	maintenance handling criteria	ball lock assembly to mate with project reference drawings, project to utilize CCB/gamma gate for replacement	LSH	Equipment used for removal to be determined by project. This component is glass contacting
enc51	spare lid plug -small	operating life (predicted)	life of melter	LSH	
enc53	spare lid plug -small	weight of component	85 lb approximate	LSH	
htg28	startup heater	dimensions - envelope	19.5" dia. X 68" long	LSH	diameter includes the tadpole gasket (.25"), length does not include the lifting bail
htg03	startup heater	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	equipment used for removal determined by project, not a glass contact component
htg02	startup heater	operating life (predicted)	temporary component used at melter startup only, can be re-used for subsequent melter start ups.	LSH	operations decision for subsequent re-use
htg31	startup heater	weight of component	518 lb approximate	LSH	
tmp11	thermocouple - discharge chamber	dimensions - envelope	7" dia. X 71" long	LSH	envelope length includes the lifting bail
tmp07	thermocouple - discharge chamber	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	
tmp06	thermocouple - discharge chamber	operating life (predicted)	12 months	LSH	type "N" or type "S" material
tmp13	thermocouple - discharge chamber	weight of component	19 lb approximate	LSH	
tmp21	thermocouple - melter electrode extension	dimensions - envelope	53" long	LSH	
tmp17	thermocouple - melter electrode extension	maintenance handling criteria	no specific handling features incorporated in the design, hands on replacement only	LSH	thermocouple manually removed through access port on side of melter after disconnecting lemo connector
tmp16	thermocouple - melter electrode extension	operating life (predicted)	12 months	LSH	type "N" or type "S" material
tmp23	thermocouple - melter electrode extension	weight of component	not to exceed 25 lb	LSH	
tmp68	thermocouple - melter electrode extension cooling air exhaust	dimensions - envelope	20" long, dia. not to exceed 6"	LSH	
tmp67	thermocouple - melter electrode extension cooling air exhaust	maintenance handling criteria	no specific handling features incorporated in the design, hands on replacement only	LSH	thermocouple manually removed through access port on side of melter after disconnecting lemo connector
tmp66	thermocouple - melter electrode extension cooling air exhaust	operating life (predicted)	life of melter	LSH	
tmp70	thermocouple - melter electrode extension cooling air exhaust	weight of component	not to exceed 25 lb	LSH	

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
tmp26	thermocouple - melter glass pool and plenum	operating life (predicted)	6 months	LSH	thermocouples designed integral to bubblers, changed out with bubblers, no specific mechanical handling required
tmp41	thermocouple - melter refractory	dimensions - envelope	7" dia. X approximately 119" long	LSH	
tmp37	thermocouple - melter refractory	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	
tmp36	thermocouple - melter refractory	operating life (predicted)	12 months	LSH	
tmp43	thermocouple - melter refractory	weight of component	not to exceed 25 pounds	LSH	
tmp74	thermocouple - melter view port	dimensions - envelope	20" long, dia. not to exceed 6"	LSH	
tmp73	thermocouple - melter view port	maintenance handling criteria	no specific handling features incorporated in the design, hands on replacement only	LSH	thermocouple manually removed through access port on side of melter after disconnecting lemo connector
tmp72	thermocouple - melter view port	operating life (predicted)	life of melter	LSH	
tmp75	thermocouple - melter view port	weight of component	not to exceed 25 lb	LSH	
tmp52	thermocouple - startup	dimensions - envelope	7" dia. X 131.9" long	LSH	overall thermocouple assembly plus, ball lock lifting assembly plus the lifting assembly support stand
tmp47	thermocouple - startup	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	Equipment used for removal to be determined by project. This component is glass contacting
tmp46	thermocouple - startup	operating life (predicted)	used for start-up only - should last through multiple melters	LSH	
tmp54	thermocouple - startup	weight of component	45 lb approximate	LSH	
tmp77	thermowell - discharge chamber	dimensions - envelope	10.25" dia. X 58" long	LSH	diameter includes shoulder screws (.625" long) to attach lifting bail, length does not include the lifting bail
tmp79	thermowell - discharge chamber	maintenance handling criteria	vertical lift with overhead device, lifting bail on component	LSH	
tmp57	thermowell - discharge chamber	operating life (predicted)	life of melter	LSH	
tmp76	thermowell - discharge chamber	operating life (predicted)	life of melter	LSH	
tmp78	thermowell - discharge chamber	weight of component	67 lb approximate	LSH	
tmp60	thermowell - startup	dimensions - envelope	6.91" dia. X 110.94" long	LSH	envelope length includes the ball lock lifting assembly, envelope diameter includes the tadpole gasket (.25" dia..)
tmp63	thermowell - startup	maintenance handling criteria	ball lock assembly to mate with project reference drawings, project to utilize CCB/gamma gate for replacement	LSH	Equipment used for removal to be determined by project. This component is glass contacting
tmp64	thermowell - startup	operating life (predicted)	potentially reusable for other melters - used for start up only	LSH	
tmp59	thermowell - startup	weight of component	105 lb approximate	LSH	weight obtained from total weight of thermowells (208.9 lbs.) from reference and divided by 2

Tag	Component (2, 3)	Interface Detail(2, 3)	Interface Criteria	System/Area	Comments
env88	wheels	clearance envelope for melter wheels/guide roller assemblies	guide roller assemblies may not exceed 5.4" below the top of the rail elevation established in env60	LMH	
env10	wheels	maintenance handling criteria	N/A - life of melter component	LSH	so long as the wheel loads do not exceed allowables, no maintenance is required. Project responsible for handling non-routine maintenance requirements.
env69	wheels	maximum wheel loading	Does not exceed load limits as defined by wheel supplier, thurst bearing capacity of 66,400 pounds limiting thrust static load of 196,000 pounds, and a radial bearing capacity of 138,000 pounds, radial static load of 276,000 pounds.	LMH	
env71	wheels	quantity and location	12 total, 6 per side evenly spaced along ~15' width of melter	LMH	
env75	wheels	type/materials	Osborn International, Plain Yoke Roller PLRY-10, Heavy Duty Shaft SHB-4250	LMH	
env76	wheels	vertical displacement criteria	maximum wheel vertical displacement = 1/16" over any 150" length	LMH	

Notes:

1 Column Descriptions
"Tag" - Detail identifier. Not to be reused.
"Component" - Description of specific melter SSC for which the interface detail is associated, use as a sorting column.
"Interface Detail" - Description of interface/design detail in question. Use "Component" column for complete detail description.
"Interface Criteria" - Interface/design data, based on requirements in the specification.
"System/Area Locators" - developed in accordance with project procedures, identifies impacted discipline.
"Comments" - For providing status and/or additional clarification.
2 Write key words first, followed by secondary description if necessary.
3 Use these columns together to fully define interface detail.
4 N/A - not applicable
5 Interproject interface detail, not a subcontractor/project interface detail.

Appendix C - CSA Concurrence for Use of R_p

From: Therlault, Philippe
Sent: Wednesday, February 04, 2015 2:07 PM
To: Vincent, Travis R
Cc: Peters, Richard D (WTP); Wilcox, Wade
Subject: RE: Request for the Rp=3.0 for the Qualification of the LAW Melters

I concur with the use of Rp = 3.0 in this application.

Thank you

Philippe Thériault | WTP CS&A Functional Manager
Bechtel National Inc. | 2435 Stevens Center, Richland, WA, 99354
[illegible]
T: 509-371-[illegible] | M: 509-521-[illegible] | E: prtheria@bechtel.com

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From: Vincent, Travis R
Sent: Wednesday, February 04, 2015 12:58 PM
To: Theriault, Philippe
Cc: Peters, Richard D (WTP); Wilcox, Wade
Subject: Request for the Rp=3.0 for the Qualification of the LAW Melters

Philippe,
Per Section 4.3.1 of 24590-WTP-3PS-FB01-T0001 Rev 6, I'm requesting the use of Rp=3.0 in UBC-97 section 1632, equation (32-2), for the seismic qualification of the LAW Melters.

The LAW melters are seismically supported by the LAW melter rails that are support by the +3 elevation of the LAW building.

Please advise.

Regards,
Travis Vincent
WTP – PD Functional Manager
Main K-121
509-371-8597

Issued by RPP-WTP PDC

Specification Change Notice

CHANGE DOCUMENT NO. 24590-LAW-3PN-LMP-00002

JOB NO.	TITLE FOR CHANGE NOTICE		
24590	Update Seismic Clamp Installation		
DOCUMENT NUMBER	REV	DOCUMENT NUMBER	REV
24590-LAW-3PS-LMP-T0002	1		

PART OF DESIGN CHANGE PACKAGE (DCP)? ☐ Yes ☒ No DCP No.: Rev:

JUSTIFICATION FOR CHANGE

Is the change associated with a Q SSC? ☒ Yes ☐ No

If yes, was margin reduced? ☐ Yes ☒ No

If margin was reduced provide Calculation or MAJ number:

Justification:

The spring compression distance as indicated in this change was determined by the structural analysis group to provide the required force loading for seismic motion. This SCN is issued concurrently with calculation 24590-LAW-M2C-LMP-00002 to provide this technical basis.

Supersedes Change Document ☐ Yes ☒ No

REQUIREMENTS REVIEW

Client Approval Required ☐ Yes ☒ No Interface Resolution Required * ☐ Yes ☒ No

Address any "yes" answers in the description

DESCRIPTION OF CHANGE

Specification Changes Retroactive ☐ Yes ☒ No

Change Section 4.12 as shown in markup on following page.

ORIGINATOR	CHECKER
ORG/Discipline – Rich Peters *Rich Peters*	Dick McGrew *Dick McGrew*

Approval(s)

Title LAW MECH EGS P. RAJAGOPALAN *[signature]*	Title N/A	Title N/A	Title N/A

Date *(inserted by final approver)*: 11/19/15

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4.11.6 Construction to move the melter North, align the North East Seismic Pin slots and install the Seismic Pin (24590-QL-POA-MQR0-00001-02-00015) through Seismic Pin Support Frame and into the mating Seismic Pin Rail Slot. Note: Construction to monitor the East/West position of the wheels during Melter movement to ensure the wheel to rail overlap does not exceed 0.25".

4.11.7 Construction to install the North West Seismic Pin (24590-QL-POA-MQR0-00001-02-00015) through North West Seismic Pin Support Frame and into the mating Seismic Pin Rail Slot, install Shims (items 58, 59, and 60 of WTP-M-11950) as required to fill the space between the Seismic Pin Support Frame and the melter base, and snug tighten Bolts (items 21 of WTP-M-11950).

4.11.8 Construction to measure the "Melter Discharge Spout centerlines relative to as-built LAW Container centerline with the Elevator in the lifted/pour position" for the purpose of documenting the alignment.

Hold Point 25 - Contractor to verify the "Melter Discharge Spout centerlines relative to as-built ILAW Container centerline with the Elevator in the lifted/pour position" are within tolerance IAW 24590-WTP-FC-M-12-0350 based on Construction's documentation.

Note: If the alignment exceeds the tolerance specified in 24590-WTP-FC-M-12-0350, the melter may be moved North or South by installing another combination of Shims (items 58, 59, and 60 of WTP-M-11950) between the Seismic Pin Support Frame and the melter base after Contractor approval.

4.11.9 Construction to tighten Bolts (items 21 of WTP-M-11950) and install Nuts (items 61 of WTP-M-11950) IAW WTP-M-11950

4.12 Installing Base Seismic Clamp Assemblies (items 23 of WTP-M-11950)

THIS SCN

~~4.12.1 Construction to tighten Nut (item 3 of WTP-M-11715) until Belleville washers (items 6 of WTP-M-11715) are fully compressed on each Base Seismic Clamp Assembly.~~

4.12.1 ~~4.12.2~~ Construction to install the 10 Base Seismic Clamp Assemblies, Bolts, and Washers (items 23, 24, and 25 of WTP-M-11950) to the melter base IAW WTP-M-11950.

~~4.12.3 Construction to loosen the adjustment Nut (item 3 of WTP-M-11715) on each Base Seismic Clamp Assembly until the resulting compressed height of the stacked Belleville Washers (item 6 of WTP-M-11715) is equal to 75% of the uncompressed height specified on WTP-M-11715 within a tolerance of +0.0/-0.03 inches.~~

~~4.12.4 Construction to verify the end of the Seismic Retainer is touching the side of the melter rail and the Nut should be loose. If this is not the case, insert stainless steel shim material (minimum 5 1/2" by 5 1/2") as needed between the Seismic Retainer and the melter rail to achieve the prescribed height while maintaining the compressed height. Tighten the two Nuts (items 3 of WTP-M-11715) together without disturbing the preload on the Belleville Washers.~~

4.12.2 Shim as necessary between seismic retainer head and melter rail to achieve a final spring compression set on each seismic clamp assembly of 0.258 +/- 0.010 inch, with jam nuts (item 3) locked in place with a minimum total gap of 3/8 inches between nut (item 3) and washer (item 5) and the Clamp Frame (item 1).

Issued by RPP-WTP PDC

BECHTEL	Mechanical Data Sheet: LAW Melter 1	Data Sheet Number	24590-LAW-M0D-LMP-00001
		Component Tag Number	LMP-MLTR-00001

Site: Hanford
Project: RPP-WTP
Project No: 24590
Building: LAW Facility, Lower Melter Gallery, Room L-0112
System: LMP
Function: Convert blended LAW slurry and glass formers into glass and deliver the glass to containers
Quality Level/Seismic Classification: Q/SC-III (Note 1)
Equipment/Environment Qualification: Reference 1
Corrosion Evaluation: Reference 18

MECHANICAL (References)					
Melter Design Life (9, page 6)	years	5	Melter Base, Rail to Rail Center Distance (16)	ft-in	28 - 4
Melter Outside Envelope, installed condition, L x W x H (3, 4)	inch	256 x 367 x 190			
Estimated Maximum Assembled Weight, Empty, no glass, no cooling water (8, Table 7-3)	pounds	650,000			
Estimated Maximum Assembled Weight with Glass and Cooling Water (8, Table 7-3)	pounds	700,000			

PROCESS (References)					
Design Glass Production (9, page 7)	MT/D	15	Melt Pool Temperature, Maximum (13, page 24)	°F	2192
Maximum Operating Glass Pool Depth (13, page 72)	inch	31.5	Melter Cooling Water (15)	gal/min	316
Glass Tank Volume (13, page 30)	ft^3	270	Melter Cooling Water (15)	Delta T °F	8.5
Glass Tank Surface Dimensions, L x W (13, page 30)	inch	80 x 194	Beta/gamma dose rate from glass (17)	Rad/hr	260
Melt Pool Temperature, Operating (13, page 24)	**°F**	**2102 +/- 45°F**			

ELECTRICAL (References)	
Electrodes, kW (10)	1430 maximum
Start-up Heaters, kW (11)	25.1 maximum per heater element, 452 total maximum
Discharge Chamber, kW (11)	75 maximum per chamber

MAJOR COMPONENTS - Materials Ref 14 (pages)			
Gas Barrier base, walls, and lid (44)	Alloy 690	Electrodes and extensions (34)	Alloy 690
Discharge trough and dam (35)	Alloy 690	Cooling Panels (pages 44, 46)	C276, 316L
Shielded Enclosure (46)	A36, A500		
Film Cooler (39)	Alloy 690, Alloy 625		

REPLACEABLE COMPONENTS Ref 12			
	Design Life (months)		Design Life (months)
Glass pool and plenum thermocouples	6	Discharge Chamber Thermocouples	12
Refractory Thermocouple	12	Bubblers	6
Electrode Extension Thermocouples	12	Air Lift Lance	life of melter
Electrode Extension Cooling Air Thermocouple	life of melter	Glass Level detector	life of melter
Feed Nozzle	life of melter	Spare Lid Plugs	life of melter
Film Cooler	life of melter	Discharge Chamber vent line and vent insert	life of melter
Discharge Chamber Lid Assembly (incl heaters)	life of melter	Leak detectors	life of melter
Discharge Chamber Thermowell	life of melter		

BECHTEL	**Mechanical Data Sheet: LAW Melter 1**	Data Sheet Number	24590-LAW-M0D-LMP-00001
		Component Tag Number	LMP-MLTR-00001

NOTES

1. Subcomponents may be graded CM and SC-IV
2. Contents of this document are Dangerous Waste Permit affecting.
3. Incorporated 24590-LAW-M6N-M80T-00008 and further revised with updated dose values. Updated "Replaceable Components", added "Quality Level/Seismic Classification", added "Equipment/Environment Qualification", updated References. Deleted Controls and Instrumentation references, deleted elevation dimensional data. Complete revision, rev bars not shown.
4. Updated references, cooling water data and added operating temperature. Design margin is not affected. This datasheet contains data developed in calculations where margin is addressed.

REFERENCES

Reference #	
1	24590-LAW-M0Q-LMP-00003, Rev 0, Equipment Qualification Datasheet for Low Activity Waste (LAW) Melters
2	24590-LAW-MF-LMP-00001, Rev 0, LAW Melter Assembly LAW-MLTR-00001/00002 Isometric View
3	24590-LAW-MF-LMP-00002, Rev 0, LAW Melter Assembly LAW-MLTR -00001/00002 Plan View
4	24590-LAW-MF-LMP-00003, Rev 0, LAW Melter Assembly LAW-MLTR -00001/00002 East, West And North
5	24590-LAW-MF-LMP-00004, Rev 0, LAW Melter Assembly LAW-MLTR -00001/00002 Section A-A
6	24590-LAW-M6-LMP-00012001, Rev 0, P&ID LAW - LAW Melter Process System - Melter 1 Feed Nozzles Cooling System and Feed Nozzles
7	24590-LAW-M6-LMP-00042001, Rev 0, P&ID LAW - LAW Melter Process System - Melter 2 Feed Nozzles Cooling System and Feed Nozzles
8	**24590-LAW-M2C-LMP-00002, Rev A, LMP-MLTR-00001 & LMP-MLTR-00002, LAW Melter Units, Structural and Seismic Analysis with ANSYS**
9	24590-LAW-3PS-AE00-T0001, Rev 6, Engineering Specification for Low Activity Waste Melters
10	24590-LAW-M6C-LMP-00011, Rev 1, Electrode Power Requirements for LAW Melter
11	24590-LAW-RPT-E-03-002, Rev 1, LAW Electrical Requirements for Startup and Discharge Heaters
12	24590-101-TSA-W000-0010-409-1137, Rev 00A, LAW Melter Life Report
13	24590-101-TSA-W000-0010-409-359, Rev N/A, LAW Melter System Description
14	24590-101-TSA-W000-0010-42-02 Rev 00B, Report - LAW Melter Materials Selection
15	24590-LAW-MEC-PCW-0000**2**, Rev 0, **Melter Panels Cooling Water Heat Exchangers PCW-HX-00004A/B and PCW-HX-00005A/B Sizing Calculation**
16	24590-LAW-M0-LMH-00002001, Rev **3**, LAW Vitrification System LMH Design Proposal Drawing LSM Rail Assembly
17	24590-WTP-Z0C-W13T-00010, Rev F, Contact Dose Rates to Equipment from Beta and Gamma Emitters
18	**24590-LAW-N1D-LMP-00001, Rev 1, Corrosion Evaluation of LMP-MLTR-00001 & LMP-MLTR-00002 - LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels**

Date	Rev	Reason for Revision	Originator	Checker	Approver
11/19/15	3	See Note 4. Changes are shown in bold/underline.	Originator By: Rich Peters - rpeters1 Org Name: LAW Mech Sys Lead Placed: Nov 12, 2015, 2:16 pm	Checked By: Matt Meyer - mfmeyer1 Org Name: LAW - Mechanical Systems Placed: Nov 12, 2015, 2:39 pm	P. Rajagopalan
3/5/2015	2	See Note 3.	Rich Peters	Matt Meyer	Prabhu Rajagopalan
10/15/2002	0	Issued for Design	M. Hall	L. Donovan	Will Eaton

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BECHTEL	**Mechanical Data Sheet: LAW Melter 2**	Data Sheet Number	24590-LAW-M0D-LMP-00002
		Component Tag Number	LMP-MLTR-00002

Site: Hanford
Project: RPP-WTP
Project No: 24590
Building: LAW Facility, Lower Melter Gallery, Room L-0112
System: LMP
Function: Convert blended LAW slurry and glass formers into glass and deliver the glass to containers
Quality Level/Seismic Classification: Q/SC-III (Note 1)
Equipment/Environment Qualification: Reference 1
Corrosion Evaluation: Reference 18

MECHANICAL
(References)

Melter Design Life (9, page 6)	years	5	Melter Base, Rail to Rail Center Distance (16)	ft-in	28 - 4
Melter Outside Envelope, installed condition, L x W x H (3, 4)	inch	256 x 367 x 190			
Estimated Maximum Assembled Weight, Empty, no glass, no cooling water (8, **Table 7-3**)	pounds	**650,000**			
Estimated Maximum Assembled Weight with Glass and Cooling Water (8, **Table 7-3**)	pounds	**700,000**			

PROCESS
(References)

Design Glass Production (9, page 7)	MT/D	15	Melt Pool Temperature, Maximum (13, page 24)	°F	2192
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Glass Tank Volume (13, page 30)	ft^3	270	Melter Cooling Water (15)	Delta T °F	**8.5**
Glass Tank Surface Dimensions, L x W (13, page 30)	inch	80 x 194	Beta/gamma dose rate from glass (17)	Rad/hr	260
Melt Pool Temperature, Operating (13, page 24)	**°F**	**2102 +/- 45°F**			

ELECTRICAL
(References)

Electrodes, kW (10)	1430 maximum
Start-up Heaters, kW (11)	25.1 maximum per heater element, 452 total maximum
Discharge Chamber, kW (11)	75 maximum per chamber

MAJOR COMPONENTS - Materials
Ref 14 (pages)

Gas Barrier base, walls, and lid (44)	Alloy 690	Electrodes and extensions (34)	Alloy 690
Discharge trough and dam (35)	Alloy 690	Cooling Panels (pages 44, 46)	C276, 316L
Shielded Enclosure (46)	A36, A500		
Film Cooler (39)	Alloy 690, Alloy 625		

REPLACEABLE COMPONENTS
Ref 12

	Design Life (months)		Design Life (months)
Glass pool and plenum thermocouples	6	Discharge Chamber Thermocouples	12
Refractory Thermocouple	12	Bubblers	6
Electrode Extension Thermocouples	12	Air Lift Lance	life of melter
Electrode Extension Cooling Air Thermocouple	life of melter	Glass Level detector	life of melter
Feed Nozzle	life of melter	Spare Lid Plugs	life of melter
Film Cooler	life of melter	Discharge Chamber vent line and vent insert	life of melter
Discharge Chamber Lid Assembly (incl heaters)	life of melter	Leak detectors	life of melter
Discharge Chamber Thermowell	life of melter		

	Mechanical Data Sheet: LAW Melter 2	Data Sheet Number	24590-LAW-M0D-LMP-00002
		Component Tag Number	LMP-MLTR-00002

NOTES

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3. Incorporated 24590-LAW-M6N-M80T-00008 and further revised with updated dose values. Updated "Replaceable Components", added "Quality Level/Seismic Classification", added "Equipment/Environment Qualification", updated References. Deleted Controls and Instrumentation references, deleted elevation dimensional data. Complete revision, rev bars not shown.

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4	24590-LAW-MF-LMP-00003, Rev 0, LAW Melter Assembly LAW-MLTR -00001/00002 East, West And North
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13	24590-101-TSA-W000-0010-409-359, Rev N/A, LAW Melter System Description
14	24590-101-TSA-W000-0010-42-02 Rev 00B, Report - LAW Melter Materials Selection
15	24590-LAW-MEC-PCW-0000**2**, Rev 0, **Melter Panels Cooling Water Heat Exchangers PCW-HX-00004A/B and PCW-HX-00005A/B Sizing Calculation**
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17	24590-WTP-Z0C-W13T-00010, Rev F, Contact Dose Rates to Equipment from Beta and Gamma Emitters
18	**24590-LAW-N1D-LMP-00001, Rev 1, Corrosion Evaluation of LMP-MLTR-00001 & LMP-MLTR-00002 - LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels**

Date	Rev	Reason for Revision	Originator	Checker	Approver
11/19/15	3	See Note 4. Changes are shown in bold/underline.	Originator By: Rich Peters - rpeters1 Org Name: LAW Mech Sys Lead Placed: Nov 12, 2015, 2:15 pm	Checked By: Matt Meyer - mfmeyer1 Org Name: LAW - Mechanical Systems Placed: Nov 12, 2015, 2:40 pm	P. RAJAGOPALAN
3/5/2015	2	See Note 3.	Rich Peters	Matt Meyer	Prabhu Rajagopalan
10/15/2002	0	Issued for Design	M. Hall	L. Donovan	Will Eaton

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ISSUED BY
RPP-WTP PDC

R11743694

CORROSION EVALUATION

LMP-MLTR-00001 & LMP-MLTR-00002
LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels Inside of Gas Barrier

Contents of this document are Dangerous Waste Permit affecting

Results

Materials Considered:

Material (UNS No.)	Acceptable Material
Carbon Steel	
Type 304L (S30403)	
Type 316L (S31603)	
Al-6XN® 6% Mo (N08367)	
Hastelloy® C-276 (N10276)	X
Hastelloy® C-22® (N06022)	
Inconel® 690 (N06690)	X
Ti-2 (R50400)	

Materials of Fabrication **Gas Barrier – Inconel® 690 (UNS N06690)**
Cooling Panels Inside of Gas Barrier: Hastelloy® C-276 (UNS N10276)

Inputs and References

- Conditions for Gas Barrier
  - Temperature of base: 121 °F to 133 °F (24590-QL-HC4-W000-00094-05-00001)
  - Temperature of side walls: 206 °F to 358 °F (24590-QL-HC4-W000-00094-05-00001)
  - Temperature of lid: 185 °F (24590-LAW-M2C-LMP-00001)
  - Stream composition: Hot side, in contact with surrounding melter conditions - assume similar to LMP14
    Cold side, in contact with cooling water - use plant cooling water (PCW)
- Conditions for Cooling Panels Inside of Gas Barrier
  - Temperature of panels (°F) (norm/max): 93/114 (24590-LAW-MEC-PCW-00005)
  - Stream composition: Hot side, in contact with surrounding melter conditions - assume similar to LMP14
    Cold side, in contact with cooling water - use plant cooling water (PCW)
- Corrosion allowance
  - Components within the gas barrier (excluding cooling panels): 0.125 inch (24590-QL-HC4-W000-00094-05-00001)
  - Cooling panels located inside the gas barrier: 0.031 inch (One corrosion allowance for both heat transfer surfaces)

Assumptions and Justifications:

- Material selections process was performed under contract with Duratek and is documented in 24590-101-TSA-W000-0010-42-02, *Report - LAW Melter Materials Selection.*
- The LAW melters have a minimum design life of 5 years and will be replaced multiple times throughout the life of the plant.

Operating Restrictions

- Once filled, the gas barrier and cooling panels shall not be idled, with no flow, for periods longer than 72 hours.
- Plant cooling water is clean, non-scaling, non-silting and not prone to biological growth. Sampling and chemical addition will ensure the quality of the water is maintained.

Concurrence [signature]
Operations

REV	DATE	REASON FOR REVISION	ORIGINATE	CHECK	REVIEW	APPROVE
1	11/13/15	Extensive changes to text throughout to clarify content in response to client review. No revision bars shown	Originator By: Debbie Adler - dadler Org Name: MET Placed: Oct 30, 2015, 7:32 am	Checked By: A. Rangus - arangus Org Name: Bechtel Placed: Oct 30, 2015, 11:19 am TRangus	Reviewed No Comments By: Robert Davis - rbdavis Org Name: Bechtel Placed: Nov 04, 2015, 7:05 am RBDavis	[signature] TErwin
0	4/16/15	Initial Issue	DLAdler	TRangus	RBDavis	TErwin

CORROSION EVALUATION

This bound document contains a total of 8 sheets.

CORROSION EVALUATION

Corrosion/Erosion Detailed Discussion

The LAW melter is "encapsulated" in an Inconel® 690 outer shell, although some air in-leakage is permitted. Within the outer shell of the lower melter assembly are cooling panels constructed of Hastelloy® C-276 (24590-101-TSA-W000-0010-42-02, *Duratek LAW Melter Materials Selection Report REP-WTP-11003*). There is no stainless steel or carbon steel within the gas barrier. The materials of construction for the LAW melter were selected by Duratek under their contract with WTP. Materials were selected for their suitability for use and corrosion resistance in the conditions expected in the melter environment. Melter offgas corrosion testing was performed and documented in the Duratek LAW Melter Materials Selection Report. Results are shown here:

LAW Pilot Off-gas Corrosion Coupon Results

Alloy	Comments	Pit Depth	Metal loss*	
		mils	mm	mils
Hastelloy® C-22	Undulating metal surface with deep local pits; remnants of deposits in places.	0.2	0.0375	1.48
Hastelloy® C-276	Pitted on one side only; surfaces smooth with scalloped profile; little deposit retention.	0.5	0.0295	1.16
Nicrofer 6025HT	Occasional pits; deposit thicker on one side of coupon.	0.1	0.0055	0.22
Inconel® 690	Relatively smooth surface; deposit thicker on one side of coupon.	0.05	0.0095	0.37
HR160	Significant localized pitting in some places; oxide formed.	2.2	0.0575	2.26

* Metal Loss is represented as the average material loss over the test area for a specific coupon.

The alloys stated in the table above were placed into the LAW Pilot Melter offgas system for 452 days. As seen above in the table, Hastelloy® C-276 and Inconel® 690 exhibited acceptable pitting and corrosion rates.

The waste feed is pumped onto the surface of the molten glass where heat from the melt pool evaporates water, decomposes various chemicals and organics, and melts into the glass pool. The glass pool is lined with corrosion resistant refractory blocks stacked in layers with the outermost surface being water-cooled. The gas space above the glass pool is also lined with refractory to produce a plenum where entrained feed materials separate from the steam and gases exiting the melter. The melter is capped with a lid, which is lined on its bottom surface with corrosion-resistant refractory. The entire melter refractory package is encased by a metallic shell referred to as the gas barrier that allows the melter to be under vacuum and prevents the escape of melter exhaust gases.

The gas compositions for the inlet stream to the LOP system are used as a conservative limit. Because the offgas from the melter contains about 40 % water, condensation is feasible at the expected temperatures. The presence of NOx and SOx is expected to result in a condensate at the cooling panels with a pH of approximately 1.5; some chloride will be present along with fluoride.

1 General/Uniform Corrosion Analysis

a Background

General corrosion or uniform corrosion is corrosion that is distributed more-or-less uniformly over the surface of a material without appreciable localization. This leads to relatively uniform thinning on sheet and plate materials and general thinning on one side or the other (or both) for pipe and tubing. It is recognized by a roughening of the surface and by the presence of corrosion products. The mechanism of the attack typically is an electrochemical process that takes place at the surface of the material. Differences in composition or orientation between small areas on the metal surface create micro-anodes and cathodes that facilitate the corrosion process.

Corrosion test results of melter materials have been reported by Wicks (1980), Imrich and Jenkins (1996), Imrich K.J (2001), and Keith S. Matlack (2011). The materials used in the melter systems were exposed to the liquid glass, in the splash zone, and vapor space. Melts of pure frits are generally more corrosive than melts that contain concentrated sludge waste. The corrosion is caused by the alkali oxides (6 to 7 wt%) in the melt. Alloys with molybdenum are singularly called out as susceptible to corrosion, due to the silica forming $MoSi_2$ compounds that can affect the material integrity. Above the melt, the corrosion increases as the acid gasses form, are wetted by the water vapor, and are carried by gas flow throughout the gas barrier. High temperature nitric acid (HNO_3) vapor attacks most alloys. Decomposition of sodium nitrate will also produce nitrogen oxides which will corrode most nickel alloys with the exception of Inconel® 690, which is a nickel-chromium-iron alloy and does not have molybdenum. The effect molten glass and pilot melter offgas had on Inconel® 690 coupons was reported by Imrich (1996) in a series of LAI (liquid air interface) tests; corrosion rates in the splash zone were 15 mpy and in the vapor space 8 mpy. Preferential edge attack was observed.

b Component-Specific Discussion- Gas Barrier

The melter gas-barrier was fabricated from UNS N06690 (Inconel® 690). This material has been specified to prevent corrosion by warm, wet, salt deposits. During normal operations, the temperatures at the gas barrier will be 133 °F at the base, 185 °F at the lid, and 206 to 358 °F at the side walls. The process conditions for the hot-side are expected to be similar to those shown for stream LMP14 in 24590-WTP-RPT-PR-04-0001-04, *WTP Process Corrosion Data – Volume 4*. The cold side of the lid will be in contact with plant cooling water (PCW). The material used to construct the gas barrier and gas barrier lid is resistant to general corrosion in the expected offgas environment as well as any condensate containing low levels of chloride and fluoride salts, and NOx and SOx; see sections 4.2.3 and 4.2.5

of 24590-101-TSA-W000-0010-42-02. The cold side of the gas barrier lid exposed to PCW water is immune to general corrosion as the PCW water is treated and benign. The effect molten glass and pilot melter offgas had on Inconel® 690 coupons was reported by Imrich (1996) in a series of LAI tests; corrosion rates in the splash zone were 15 mpy and in the vapor space 8 mpy. These conditions are more extreme than those expected at the gas barrier and are therefore bounding. It is apparent that margin has been provided since the 8 mpy seen in more extreme scenarios would only corrode 40 mils of the 125 mils allotted over the minimum design life of the melters (5 years).

c Component-Specific Discussion- Cooling Panels

The cooling panels within the gas-barrier will be fabricated from UNS N10276 (Hastelloy® C-276). This material has been selected because the cooling panel surfaces are likely to have deposits of condensed plenum gas salts and will probably be wet/moist from water vapor condensation. During normal operations, the temperature at the cooling panels will be 93 °F (114 °F max). The process conditions for the cooling panels' hot sides are conservatively assumed to be similar to those shown for stream LMP14 in 24590-WTP-RPT-PR-04-0001-04. The cold sides of the cooling panels will be in contact with PCW water. Hastelloy® C-276 is immune to general corrosion in PCW as this water is treated and benign. See section 4.2.5.2 of 24590-101-TSA-W000-0010-42-02 for additional discussion.

The inlet room air flows from the bottom of the melter to the top, mixing with the melter gases in the plenum and out to the film cooler to the offgas treatment systems. The cooling panels are located adjacent to the inlet vents that draw clean air into the melter offgas system. The gas barrier annulus contains the cooling panels and has a passive purge of 10 volume changes per hour to prevent the intrusion and buildup of salts from the plenum (24590-101-TSA-W000-0010-42-02).

Section 4.3.2 of the design guide 24590-WTP-GPG-M-047, *Preparation of Corrosion Evaluations*, explains that a zero corrosion allowance is acceptable on heat transfer surfaces (internal & external) providing a corrosion resistant material is selected. Hastelloy® C-276 is a corrosion resistant material. The recommended corrosion allowance is consistent with Tubular Exchanger Manufacturers Association (TEMA) and other national standards used to design and fabricate heat exchangers and cooling panels. Heat transfer surfaces fabricated using high alloy corrosion resistant materials are often specified with, or assumed to have, a zero corrosion allowance. TEMA provides guidance that, in some cases, an approximate 1/64 inch is added to the thickness, above the pressure design code minimum required thickness. The recommended corrosion allowance is 1/32 inch for added conservatism. Results of testing that took place in the LAW Pilot Melter offgas system over 452 days resulted in a uniform corrosion rate of 0.9 mpy. General corrosion is not expected to be a concern during the first 5 years of melter operation since the observed corrosion rate of 0.9 mpy in the off-gas coupons does not exceed the recommended corrosion allowance of 0.031 inches (31 mils) after 5 years of operation.

Although the recommended corrosion allowance is 0.031 inches, the WTP LAW melter cooling panels were built with a corrosion allowance of 1/8" (0.125 inches), which greatly exceeds the recommended corrosion allowance and provides additional margin (24590-QL-HC4-W000-00011-03-00505, *Specification - Low Active Waste (LAW) And High Level Waste (HLW) Cooling Panel Procurement Specification*).

2 Pitting Corrosion Analysis

Pitting is localized corrosion of a metal surface that is confined to a point or small area and takes the form of cavities. Under the stated conditions, Hastelloy® C-276 and Inconel® 690 have excellent resistance to pitting corrosion (24590-101-TSA-W000-0010-42-02). Hastelloy® C-276 is commonly used in the fabrication of embossed cooling panels installed in similar environments (24590-101-TSA-W000-0010-42-02). The table above shows test results from coupons that were exposed to the LAW Pilot Melter off-gas system for 452 days. Hastelloy® C-276 experienced slight pitting to a depth of 0.5 mils and Inconel® 690 experienced almost no pitting with a reported pit depth of 0.05 mils. The recommended corrosion allowances for the cooling panels inside the gas barrier and the gas barrier itself are 0.031 inches and 0.125 inches respectively. Extrapolating the pitting data for Hastelloy® C-276 and Inconel® 690 shows it would be decades before pitting would become an issue, which is significantly longer than the melters' 5 year minimum design life. Additional information on Inconel® 690 and Hastelloy® C-276 can be found in Special Metals (2002) and Haynes International (2001).

3 Crevice Corrosion Analysis

Crevice corrosion is a form of localized corrosion of a metal or alloy surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of close proximity of the metal or alloy to the surface of another material or an adjacent surface of the same metal or alloy. Crevice corrosion is similar to pitting in mechanism and may be present at the interface between the refractory brick, and the bottom of the Inconel® 690 cooling lid and cooling panels. The cooling lid is positioned above the molten glass, and the vaporized water will condense onto the surface. Melter design anticipates crevice corrosion and limits the life of the melter, including the lid.

The Hastelloy® C-276 nominal chemistry of 57% nickel, 16% molybdenum, and 16% chromium makes it highly resistant to localized corrosion. The critical crevice corrosion temperature is 176 °F (80 °C) in a NaCl + HCl solution (>24,000 ppm chlorides at pH 2); and 203 °F (95 °C) per the ASTM G48 test with 6% Fe_2Cl_3 ferric chloride solution. Based on the operating conditions in the locations where Hastelloy® C-276 is used, crevice corrosion is not a concern during the design life of the melter.

4 Stress Corrosion Cracking Analysis

Stress corrosion cracking (SCC) is the cracking of a material produced by the combined action of corrosion and sustained tensile stress (residual or applied). In addition, sensitization of the grain boundaries is prevented with the materials recommended. Inconel® 690 has 58% nickel. At these concentrations, the alloy is generally considered immune to SCC (Sedriks 1996). The high nickel content of the alloys is expected to reduce the probability of cracking to a low value and is not a concern at the stated conditions.

CORROSION EVALUATION

5 End Grain Corrosion Analysis

End grain corrosion is preferential aqueous corrosion that occurs along the worked direction of wrought stainless steels exposed to highly oxidizing acid conditions. End grain corrosion typically is not a major concern; it propagates along the rolling direction of the plate, not necessarily through the cross sectional thickness. End grain corrosion is exclusive to metallic product forms with exposed end grains from shearing or mechanical cutting. Conditions which lead to end grain corrosion are not present in this component; therefore, end grain corrosion is not a concern during the design life of the melter.

6 Weld Corrosion Analysis

Providing correct weld procedures are followed, no preferential corrosion of weld beads or heat-affected zones is expected. Per the report from Duratek, Inconel® 690 was welded with ERNiCrFe-7 weld filler material, which is essentially a matching chemical composition to Inconel® 690. The Hastelloy® C-276 cooling panels were specified by Duratek-BNFL and fabricated by Tranter. Review of vendor submittals for weld procedures and other design media was performed by Bechtel. Supplier Quality oversight and standard practices for welding and inspections demonstrate that the proper filler metal for joining the two metals was used.

7 Microbiologically Influenced Corrosion Analysis

Microbiologically influenced corrosion (MIC) refers to corrosion affected by the presence or activity, or both, of microorganisms. Such microorganisms can survive through a limited range of environmental conditions. The temperatures and off-gas chemistry will kill all microbes. Cooling water will be chemically treated to prevent microbiological growth and the spread of microbes through the system. Furthermore, the temperature and radiological conditions in the melter will kill those microbes associated with MIC of nickel-alloy materials.

8 Fatigue/Corrosion Fatigue Analysis

Fatigue is the process of progressive localized permanent structural change occurring in a material subjected to fluctuating stresses less than the ultimate tensile strength of the material. Corrosion fatigue is the process wherein a metal fractures prematurely under conditions of simultaneous corrosion and repeated cyclic loading at lower stress levels or fewer cycles than would be required to cause fatigue of that metal in the absence of the corrosive environment. Based on the anticipated low mechanical and thermal cycling, it can be stated that conditions which lead to fatigue or corrosion fatigue are not present in this component. Fatigue and corrosion fatigue are not a concern during the design life of the melter.

9 Vapor Phase Corrosion Analysis

The materials used in the melter systems were exposed to the liquid glass, in the splash zone, and vapor space. Above the melt, the corrosion increases as the acid gasses form and are wetted by water vapor. High temperature nitric acid (HNO_3) vapor attacks most alloys. Decomposition of sodium nitrate will also produce nitrogen oxides which will corrode most nickel alloys with the exception of Inconel® 690, which is a nickel-chromium-iron alloy and does not have molybdenum. Coupon exposure to molten glass and vapor from pilot melters was reported by Imrich (1996) in a series of LAI tests, Inconel® 690 corrosion rates in the splash zone were 15 mpy and 8 mpy in the vapor space. The temperatures in the vapor space ranged from 1112 °F to 1562 °F, while the max temperature at the gas barrier (constructed out of Inconel® 690) is 358 °F. Thus, the Defense Waste Processing Facility (DWPF) environment was harsher than that expected for these components at WTP, and the anticipated corrosion rate is expected to be less. However, even accounting for the rates from the DWPF melter, the specified 125 mil corrosion allowance would last the minimum design life of the melter.

10 Erosion Analysis

Erosion is the progressive loss of material from a surface resulting from mechanical interaction between a particle and that surface. Solid particle erosion can occur in air, steam, and water fluid systems. There is insufficient fluid flow and air flow on the exterior of the cooling panels and gas barrier to cause erosion. The lid and cooling panels use PCW water which has extremely low particulates. Such conditions are not sufficient to support erosion.

11 Galling of Moving Surfaces Analysis

Galling is a form of wear caused by a combination of friction and adhesion between moving surfaces. Under high compressive forces and movement, the friction temperatures cold-weld the two surfaces together at the surface asperities. As the adhesively bonded surface moves some of the bonded material breaks away. Microscopic examination of the galled surface shows some material stuck or even friction welded to the adjacent surface, while the softer of the two surfaces appears gouged with balled-up or torn lumps of material stuck to its surface. The surfaces are expected to be fixed in place. Galling is not a concern during the design life of the melter.

12 Fretting/Wear Analysis

Fretting corrosion refers to corrosion damage caused by a slight oscillatory slip between two surfaces. Similar to galling but a much smaller movement, the corrosion products and metal debris break off and act as an abrasive between the surfaces, classic 3-body wear problem. This damage is induced under load and repeated relative surface motion, as induced for example by vibration. Pits or grooves and oxide debris characterize this damage, typically found in machinery, bolted assemblies and ball or roller bearings. The surfaces are expected to be fixed in place. Fretting is not a concern during the design life of the melter.

CORROSION EVALUATION

13 Galvanic Corrosion Analysis

Galvanic corrosion is an electrochemical process in which one metal corrodes preferentially to another when both metals are in electrical contact, in the presence of an electrolyte. Dissimilar metals and alloys have different electrode potentials, and when two are in contact in an electrolyte, one metal acts as anode and the other as cathode. The electropotential difference between the dissimilar metals is the driving force for an accelerated attack. There is not a significant potential difference between the alloys used in the construction of the components.

14 Cavitation Analysis

Cavitation corrosion is defined as another synergistic process, the combined influence of mechanical disruption of the metal surface and the corrosion of the active metal. Cavitation occurs when the local fluid pressure drops below the vapor pressure of the fluid resulting in a liquid vapor interface or bubbles to form. Their collapse on the metal surface has sufficient energy to rupture the oxide film and depending on alloy, may be capable of removing metal. There is no fluid flow in contact with the metal part of the gas barrier, which is protected by refractory, or in the off-gas, where fluids are not present.

15 Creep Analysis

Creep is defined as a time-dependent deformation at elevated temperature and constant stress, creep is a thermally activated process. The temperature at which creep begins depends on the alloy composition. Creep failures and stress rupture failures follow the same mechanism and influenced by similar variables like temperature. Stress rupture is defined as bi-axial creep restricted to pipe like geometries. Creep is found in components subjected to heat for long periods and the creep rate generally increases as the temperature nears the melting point. The normal operating temperatures are too low to cause creep in the alloys being used.

16 Inadvertent Addition of Nitric Acid

There is no practical method of adding nitric acid.

17 Conclusion and Justification

This corrosion evaluation is for the gas barrier and cooling panels inside of the gas barrier. Both are recommended to be made from corrosion resistant alloys; Inconel® 690 for the gas barrier and Hastelloy® C-276 for the cooling panels. On the cold side of these heat exchangers, the material will be exposed to clean and treated cooling water from the PCW system. Both Inconel® 690 and Hastelloy® C-276 are corrosion resistant in near-neutral water with low chlorides; little, if any, corrosion on the water side is expected over the 5 year minimum design life. The cooling panels are attached to the outside of the melter adjacent to the refractory. The outside surface of the cooling panels will likely be coated with condensed salts as well as continually wet from water condensation. The gas barrier is made out of Inconel® 690 and is not directly exposed to the molten glass. At the stated operating conditions, end grain corrosion, weld corrosion, MIC, creep, and inadvertent nitric acid addition are not active corrosion mechanisms. Conditions which lead to fatigue or corrosion fatigue, galling, fretting, galvanic corrosion, and cavitation are not present in this component. The recommended corrosion allowances, 0.125 inches for Inconel® 690 and 0.031 inches for Hastelloy® C-276, provide sufficient margin for the melters minimum design life.

18 Margin

The DM 1200 Melter system has been designed and specified by BNFL-Duratek. The melter system is designed for a minimum life of 5 years. The corrosion evaluation design guide doesn't require a corrosion allowance for the melters since the entire unit is replaceable. Although corrosion allowances are not required by the design guide they have been provided for the gas barrier and cooling panels. The gas barrier and cooling panels are made out of two separate materials; Inconel® 690 and Hastelloy® C-276. Inconel® 690 has received extensive testing in direct contact with melter offgas. Testing revealed a corrosion rate of 8 mpy when exposed to melter offgas conditions and temperatures ranging from 1112 °F to 1562 °F. The gas barrier operates at temperatures between 121 °F and 358 °F, considerably lower than the test temperature; therefore, the gas barrier is expected to have a uniform corrosion rate less than 8 mpy. Assuming a corrosion rate of 8 mpy (conservative scenario), the melter offgas will corrode the gas barrier approximately 40 mils over 5 years; therefore, margin has been provided since a corrosion allowance of 125 mils is recommended for the gas barrier. The Hastelloy® C-276 used in the cooling panels is expected to corrode less than 5 mpy leading to 25 mils of wear after 5 years of operation, which is less than the 0.031 inches (31 mils) recommended. It is also important to note that the cooling panels were built with a 0.125 inch (125 mils) corrosion allowance, which drastically exceeds the recommended corrosion allowance and adds additional margin. Based on the data available, it is apparent that the gas barrier and cooling panels will last the minimum design life of the melter.

Localized erosion is not expected to be a concern as the fluid is air or condensed water moving at slow velocities. Therefore, localized erosion is not expected at the gas barrier or cooling panels.

Localized corrosion could occur due to warm, wet, salt deposits on the cooler parts of the gas barrier and cooling panels. However, Hastelloy® C-276 has been shown to have excellent pitting resistance under the expected conditions and has been used satisfactorily in similar environments before. Results of testing that took place in the LAW Pilot Melter offgas system over 452 days resulted in pit depths of 0.5 mils. Since 31 mils is recommended, and only 0.5 mils was lost due to pitting over 452 days, it is apparent that it would take significantly longer than 5 years before pitting becomes an issue.

The gas barrier is made out of Inconel® 690. The temperatures at the gas barrier range from 121°F to 358°F. Section 4.2.5.1 of 24590-101-TSA-W000-0010-42-02 states that Inconel® 690 has been specified for its corrosion resistance to warm, wet, salt deposits that can occur at the gas barrier interface. Results of testing that took place in the LAW Pilot Melter offgas system over 452 days resulted in pit depths of 0.05 mils (test results on sheet 3). Since 125 mils is recommended, and only 0.05 mils was lost due to pitting over 452 days, it is apparent that it would take significantly longer than 5 years before pitting becomes an issue.

CORROSION EVALUATION

19 References

1. 24590-101-TSA-W000-0010-42-02, *LAW Melter Materials Selection Report.*
2. 24590-LAW-M2C-LMP-00001, *LAW Melter Lid CFD Analysis.*
3. 24590-LAW-MEC-PCW-00005, *Design Pressure and Design Temperature for Plant Cooling Water (PCW) System.*
4. 24590-QL-HC4-W000-00094-05-00001, *Calculation - LAW Discharge Chamber and South Wall Details Temperature Profile.*
5. 24590-WTP-GPG-M-047, *Preparation of Corrosion Evaluations.*
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Additional Reading

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CORROSION EVALUATION

PROCESS CORROSION DATA SHEET (extract)

Component(s) (Name/ID #) LMP-MLTR-00001 & LMP-MLTR-00002 (LAW Melter 1&2 Gas Barrier and Cooling Panels

Facility LAW

In Black Cell? No

Chemicals	Unit	Stream ID LMP14 Gaseous
CO_2	ppmV	25,417
HCl	ppmV	558
HF	ppmV	4357
NH_3	ppmV	22
NO	ppmV	2129
NO_2	ppmV	10
SO_2	ppmV	35
SO_3(s)	mg/m^3	105
RH	%	0
Suspended Solids	wt%	n/a
Temperature	°F	n/a

ISSUED BY
RPP-WTP PDC

Document title:	**Low-Activity Waste Melter Process System Design Description**
Document number:	24590-LAW-3ZD-LMP-00001
Revision number:	0
Type:	☑ System Design Description ☐ Facility Design Description
Originator(s):	Eileen Yokuda Jeff Jones
Checked by:	Neil Darwen
Checker's signature:	Signature: [signature] Date: 10/15/15
Concurrence:	Mark Johnson
Concurrence signature:	Manager of Production Engineering Signature: Chris Musick Date: 10/30/15
Concurrence:	Ian Milgate
Concurrence signature:	Project Technical Director and Design Authority Signature: [signature] Date: ~~10/30~~ 11/4/15.
Approved by:	Natalie Harkey
Approver's position:	Systems Engineering Manager
Approver's signature:	Signature: Natalie Harkey Date: 11/4/2015

History Sheet

Rev	Reason for revision	Revised by
0	Initial issue. Supersedes 24590-LAW-3YD-LMP-00001, Rev. 4, *System Description for the System LMP, Low Activity Waste Melter*	E. Yokuda

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 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.

Contents

Appendices

Tables

Figures

1 Introduction

1.1 System Identification

This system design description (SDD) defines the technical and functional/performance requirements of the low activity waste (LAW) melter process system (LMP). This document details the waste treatment requirements, environmental compliance requirements, and authorization basis requirements of the LMP system. This SDD describes the process and functional design requirements of the LMP, including the following:

- Services and utility requirements, operating materials and supplies, and other external interfaces
- Operations limits and design bases
- Other criteria and requirements pertinent to the design of the LMP system

The boundaries, system interfaces, and functional description of the LMP are provided in Section 2.

1.2 Limitations and Scope

The scope of this document is to provide an authoritative source for the collected set of requirements applicable to the LMP system, inclusive of interface requirements with other systems. The SDD scope is limited to LMP system features that support production and/or protect equipment, personnel, and the environment. The SDD is prepared in accordance with 24590-WTP-3DP-G04B-00093, *System and Facility Design Descriptions*. The intended use of these collected requirements is to establish the following:

- Inform the LMP design effort
- Provide a validated basis upon which to confirm implementation of design requirements
- Provide the expected means of verification for requirements, including those that are post-construction (i.e., startup and commissioning test objectives and acceptance criteria)

All requirements established in this document are intended to be verified to be-implemented in design and/or physical configuration using a graded approach commensurate with importance and risk.

Where numeric values are provided within requirements in Section 3, these values are provided without additional margin. For example, if a value is established in 24590-WTP-DB-ENG-01-001, *Basis of Design* (BOD), no attempt is made to remove any margin that may or may not have gone into the establishment of that value, nor has any margin been added. Where values are stated as minimums or maximums, there is no expectation that additional margin be applied in the verifications that the design requirements have been met. Testing that is required to be performed in accordance with external codes and standards must follow the rules established in those documents.

This document is intended to be used in support of design development, design verification, turnover, startup testing, and commissioning activities. This document will be maintained current relative to changes in source requirements documents. Updates shall be made concurrent with these changes to source requirements, or implementation shall be tracked for completion in accordance with 24590-WTP-GPG-ENG-0170, *Impact Evaluation.*

Engineers are expected to be able to use the requirements in Section 3 of this document as input for design development without recourse to the upper-tier source documents or searches of the Technical Requirements Search Application (TRSA). Design engineers are still required to ensure that requirements in the discipline and functional standards incorporated by reference in Section 3 are followed. These documents contain additional criteria that are based on applications of external codes and standards, corporate best practices, and engineering management expectations for a consistent approach to design.

Certain requirement statements in this document are preceded by a "**[HOLD]**" notation. This notation is used when there are unresolved technical issues, known inconsistencies among source requirements, or other management suspensions of work requiring resolution. Requirements with the "**[HOLD]**" notation may be used to proceed with preliminary or committed design (with inclusion of appropriate holds) but shall not be used in support of fabrication or construction until the "**[HOLD]**" is removed.

The contents of Section 4 are being developed in a phased approach in support of future operations and maintenance. At this revision, only the contents of Sections 4.1.1, 4.1.2, 4.1.3, 4.1.4, and 4.1.6 have been updated and verified. Information in Sections 4.1.5, 4.2, 4.3 and 4.4 are currently reserved and will be updated in a later phase after the work to support completion of these sections has been completed.

Additional Appendices may be added in the future as needed.

1.3 Ownership and Maintenance

The Design Authority organization is responsible for the preparation and maintenance of this document through turnover of the included system to Operations. Thereafter, maintenance of this document is the responsibility of the Plant Engineering organization; however, the Engineering Design Authority organization retains responsibility for the establishment and definition of design requirements.

1.4 Definitions/Glossary

Annulus. The void space between the melter enclosure and gas barrier walls.

Base. Structural platform that supports the melter during transport and operation. Base includes the structure, cooling panels, and upper plate, which is part of the gas barrier and provides the flat, level surface for the refractory. The base includes the wheels and interface to the facility rails for both transport and restraint.

Cold Commissioning. Integrated process system testing including LMP and other systems with waste simulants that will not be radioactive but will have nitrogen oxides (NOx) and other constituent concentrations similar to what is expected from the actual tank waste. Some of this waste simulant, depending on the pH, nitrate/nitrate salt or other constituent concentrations could cause the simulant to designate as dangerous waste and could subject the material to the management requirements of the *Resource Conservation and Recovery Act of 1976* as delineated in the Dangerous Waste Permit (DWP). These tests would produce a cold cap that would produce pressures and temperatures, and non-radioactive offgas emissions including NOx similar to actual operations.

Confinement. For consistency, regardless of usage elsewhere, confinement is used in this document to denote the controls used to prevent or minimize the release or migration of airborne contaminants, including aerosols, hazardous vapors, or gases.

Containment. For consistency, regardless of usage elsewhere, containment is used in this document to denote the controls used to prevent or minimize the release or migration of liquid or liquid-entrained contaminants.

Gas Barrier. The alloy plate that surrounds the four sides of the refractory walls and the discharge chambers, covers the top of the melter base and comprises the bottom of the melter lid and the supporting structural tubing. The bottom of the melter lid is formed by two sections of the gas barrier: 1) the gas barrier lid plates that sit on top and are welded to the four gas barrier walls; and 2) the melter lid cooling cavity that sits on top of and cools the gas barrier plates.

Melter. All components inside of the melter enclosure, including the melter enclosure. In some documents, a melter is referred to as a locally shielded melter (LSM).

Melter Enclosure. The metal shield lid and the metal walls that separate the annulus from the melter gallery. This assembly is also referred to as the melter shield box.

Melter Lid Cooling Cavity. The section of the gas barrier that sits on top of the gas barrier lid plates. Low pressure cooling water circulates through baffles in the melter lid cooling cavity to cool the gas barrier plate and the plenum.

Melter Lid. The assembly of the shield lid (which is part of the melter enclosure), the melter lid cooling cavity (which is part of the gas barrier), and the gas barrier lid plates (which are part of the melter shell and gas barrier).

Melter Shell. The inner confinement boundary comprised of the gas barrier lid plates, the gas barrier walls and their support structures, and the gas barrier base plate on top of the melter base. These are all welded together. The melter shell has the credited safety function of confining offgas to the plenum and routing offgas to the LAW primary offgas process system (LOP).

Structure. Melter and discharge chamber structural steel, including bracing that support the gas barrier walls, cooling panels, melter enclosure, and the melter lid. This structure is positioned on the base.

Nonhazardous Feed Testing. Integrated process system testing including LMP and others using a non-hazardous glass former slurry.

Plenum. The area of the melter that makes up the gas space directly above the melt pool.

Primary confinement or containment. The structures, systems, or components (SSC) and their associated boundaries that confine or contain airborne and liquid contaminants under normal conditions.

Secondary confinement or containment. The structures or other design features that capture and prevent further spread or migration of airborne or liquid contaminants after they have escaped primary confinement or containment.

Shield Lid. The lid section of the melter enclosure. The shield lid covers the melter lid cooling cavity. The shield lid supports all components mounted on it and through it.

1.5 Acronyms and System Designators

1.5.1 Acronyms

ADS	air displacement slurry
AHJ	authority having jurisdiction
AISC	American Institute of Steel Construction
ALARA	as low as reasonably achievable
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers

AWFCO	automatic waste feed cut off
AWG	American wire gauge
AWS	American Welding Society
AZS	alumina zirconia silica
BNI	Bechtel National, Inc.
BOD	Basis of Design
BOF	Balance of Facilities
C3	Contamination Area
C5	Airborne Radioactivity Area
CCB	consumable changeout box
CCTV	closed circuit television
CFR	Code of Federal Regulations
CRV	concentrate receipt vessel
CTN	component tag number
DI	density indicator
DOE	US Department of Energy
DVR	design verification report
DWP	Dangerous Waste Permit
E-Stop	dedicated emergency stop button
EI	voltage indicator
EPA	Environmental Protection Agency
EQP	equipment qualification package
ES	EnergySolutions
FI	flow indicator
GFC	glass forming chemicals
GFR	glass forming reactants
GTC	general test criteria
IEEE	Institute of Electrical and Electronics Engineers, Inc.
ICN	Integrated Control Network
IDF	Integrated Disposal Facility
ILAW	immobilized low activity waste
I/O	input / output
inWC	inches of water column
IR	infrared
K3	refractory type
LAW	Low-Activity Waste (Facility)
LDR	land disposal restriction
LI	level indicator
LSM	locally shielded melter
MCC	motor control center
MFV	melter feed vessel

MFPV	melter feed preparation vessel
mrem/hr	radiation dose rate unit (millirem/hour)
MR	material requisition
MTG	metric tons of glass
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOC	Notice of Construction (Air Permit)
NOx	nitrogen oxides
NSE	Nuclear Safety Engineering
ORD	Operations Requirements Document
P&ID	piping and instrumentation diagram
PAM	post accident monitoring
PCT	product consistency test
PDI	differential pressure indicator
PDSA	preliminary documented safety analysis
PDT	differential pressure transducer
PPE	personal protective equipment
PRV	pressure relief valve
PSV	pressure safety valve
PSUP	power supply
Q	Quality
QAM	Quality Assurance Manual
R3	an area that has a target dose rate of < 2.5 mrem/hr.
R5	an area where the dose rate is > 100mrem/hr
RCRA	Resource Conservation and Recovery Act of 1976
RPP	Radiation Protection Program for Design and Construction
SAI	safety affecting instrument(ation)
SBS	submerged bed scrubber
SC	safety class
SC	seismic category
SD	system description
SDD	system design description
SDDR	supplier deviation disposition request
SDS	Safety Design Strategy for Low Activity Waste Facility
SRD	Safety Requirements Document Volume II
SS	safety significant
SSC	structures, system, or components
SPS	static power supply
TAC	test acceptance criteria
TBD	to be determined
TEEL	temporary emergency exposure limits

TI	temperature indicator
UBC	Uniform Building Code
WAC	Washington Administrative Code
WESP	wet electrostatic precipitator
WTP	Hanford Tank Waste Treatment and Immobilization Plant
Z	safety function
ZI	position indicator

1.5.2 System Designators

C3V	C3 ventilation system
C5V	C5 ventilation system
DIW	demineralized water system
GRE	grounding and lightning protection electrical system
ISA	instrument service air system
LFH	container finishing handling
LFP	LAW melter feed process system
LMH	LAW melter handling system
LMP	LAW melter process system
LOP	LAW primary offgas process system
LPH	LAW container pour handling system
LRH	LAW container receipt handling system
LSH	LAW melter equipment support handling system
LVE	low voltage electrical (480/208/120 V) system
LVP	LAW secondary offgas/vent process system
MVE	medium voltage electrical (13.8/4.16 kV) system
MXG	miscellaneous gases system
PCJ	process control system
PCW	plant cooling water system
PPJ	programmable protection system
PSA	plant service air
PTJ	process and mechanical handling CCTV system
RLD	radioactive liquid waste disposal system

2 General Overview

The LMP converts blended slurries of LAW, glass former additives, and melter feed into molten glass. The LMP begins at the air displacement slurry (ADS) pump outlets where the melter feed is fed in by the LAW melter feed process system (LFP) and ends in the melter pour caves where molten glass from the melter discharge chambers are poured into the ILAW containers. The ILAW containers are moved in and out of the pour cave by the LAW container pour handling system (LPH). Electrically, the LMP begins at the melter power supplies. Offgas produced during the melting of the slurry mixture move through the plenum section of the melter and into the LOP and LAW secondary offgas/vent process system (LVP) that process the offgas. The LMP boundary for the offgas is the opening in the melter lid where offgas exits to the LOP system. The offgas will be laden with NOx. Containment of the NOx to the plenum and LOP is the major safety concern with LMP.

Melters are located on the 3 ft elevation of LAW in room L-0112. Access to the melters is also available at the 6 ft elevation on platform LP-0112, and consumable change outs will take place on top of the shielded lid of the melter in room L-0130. The electrode and discharge heater power supplies are located on the (-) 21 ft elevation of LAW in rooms L-B002 and L-B004.

The LMP consists of two melters with the contingency to add a third. There are four main sections to each melter: the melt pool, the plenum, the melter lid, and the discharge chambers. The melt pool and the plenum are surrounded by refractory that, combined with active cooling through water jackets, confines the glass to the interior of the melter and provides thermal and electrical insulation. The plenum is the space inside of the melter above the melt pool. Offgas produced as the slurry melt collect in the plenum and are continuously discharged through the LOP. The programmable protection system (PPJ) and process control system (PCJ) monitor pressure and temperature in the plenum and melter lid to assess conditions in the LOP and LVP. The melter lid provides access to the melter for feed nozzles and instrumentation, including the agitators. The melter lid contains a cooling cavity with its own cooling system and refractory. Two discharge chambers are situated at the south end of each melter.

For each melter, the slurry is fed through a system of six feed nozzles into a glass melt pool that is maintained at a temperature of 1050 °C to 1200 °C, (1922 °F to 2192 °F). When the slurry first falls onto the top of the melt pool, the slurry will form a cold cap on top of the melt pool. Bubblers inside the melters agitate the glass pool to aid in mixing the cold cap with the molten glass. Six electrodes embedded in the refractory provide the joule heating that keeps the melt pool temperature constant and melts the cold cap. When the melt pool level inside of a melter reaches an appropriate level, the process is started to lift glass into the discharge chambers, this process is operator controlled.

Other systems that interact with the LMP include the plant cooling water system (PCW) for cooling water; the instrument service air system (ISA) for the bubblers, instruments, and some cooling; the plant service air system (PSA) for container cooling; the low voltage electrical system (LVE) and medium voltage electrical system (MVE) for low and medium electrical voltage supply; and the grounding and lightning protection electrical system (GRE) that provides grounding for the exterior metal portions of the melters. The ISA and PSA air and PCW water delivered to the LMP travels through LMP designated piping within the area surrounding the melters. The main power supply for the electrodes, the startup power supplies, the discharge heater power supplies, all wiring between these powers supplies and the melters themselves are considered part of the LMP system.

Cascading ventilation for the LMP system is provided by the LOP system which works with the C5 ventilation system (C5V) and C3 ventilation system (C3V) to provide ventilation to the melter annulus and the melter gallery, respectively.

As stated in section 14.13 of the BOD, for permitting purposes the LMP melters have been determined to be miscellaneous units in accordance with WAC 173-303-040. This drives the DWP requirement to implement WAC Tank and Ancillary equipment design criteria associated with many of the discussions in Sections 3.5.2 thru 3.14.2 of this SDD.

Figure 2-1 provides a contextual depiction of the LMP in terms of the primary interrelationships with other systems and utilities. This diagram does not differentiate among some utilities that have both normal and safety service provisions. This diagram is used in support of functional and performance definition at the system level.

Figure 2-2 provides a simplified process flow diagram of the overall LMP. Blue arrows are used in these figures to highlight the primary flow path of the LMP, orange arrows show the abnormal transfer lines, and black arrows illustrate the supporting system, utilities, and secondary flow paths. See Section 1.5.2 for the list of relevant system designators.

Figure 2-1 LAW Melter Process System Context Diagram

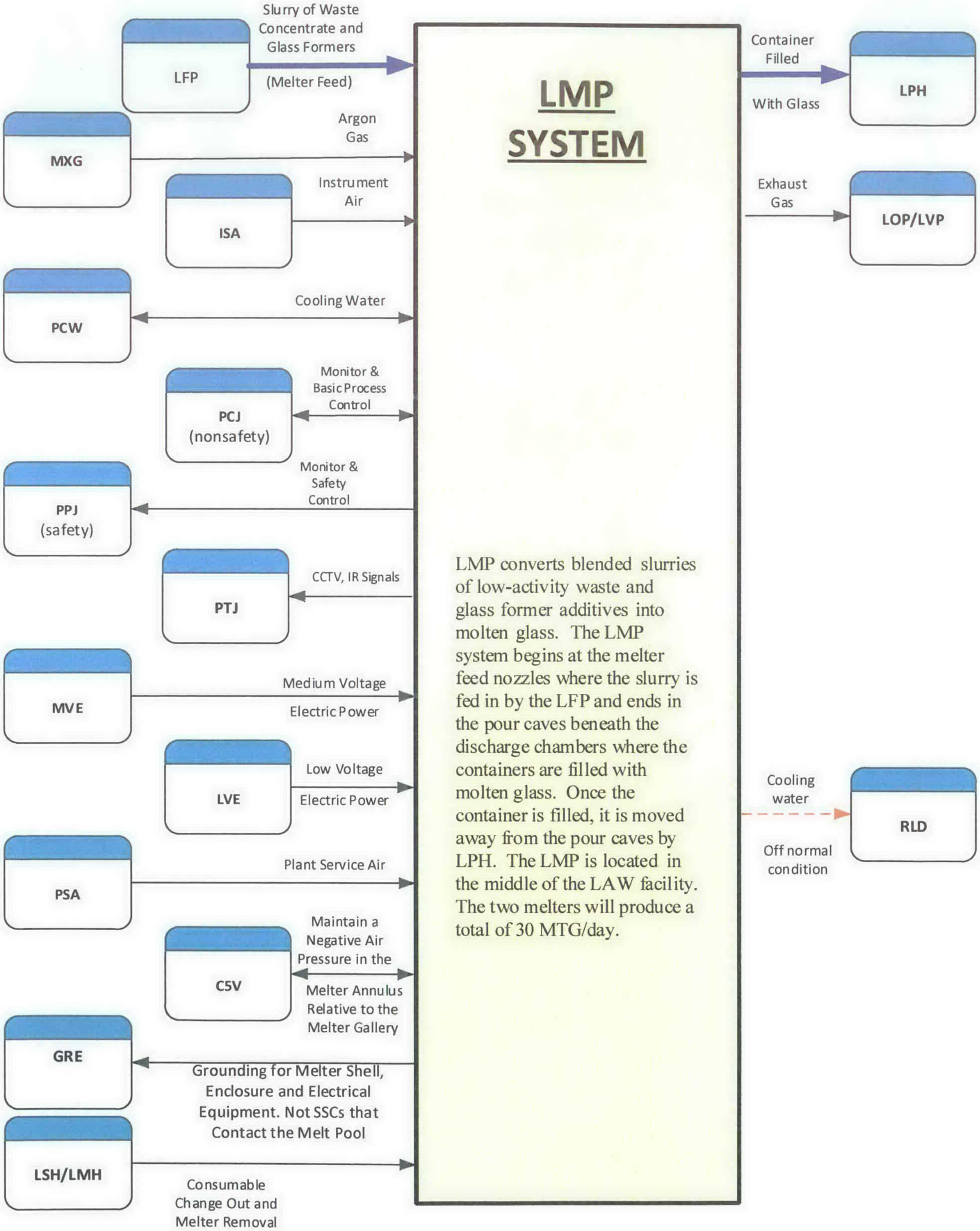
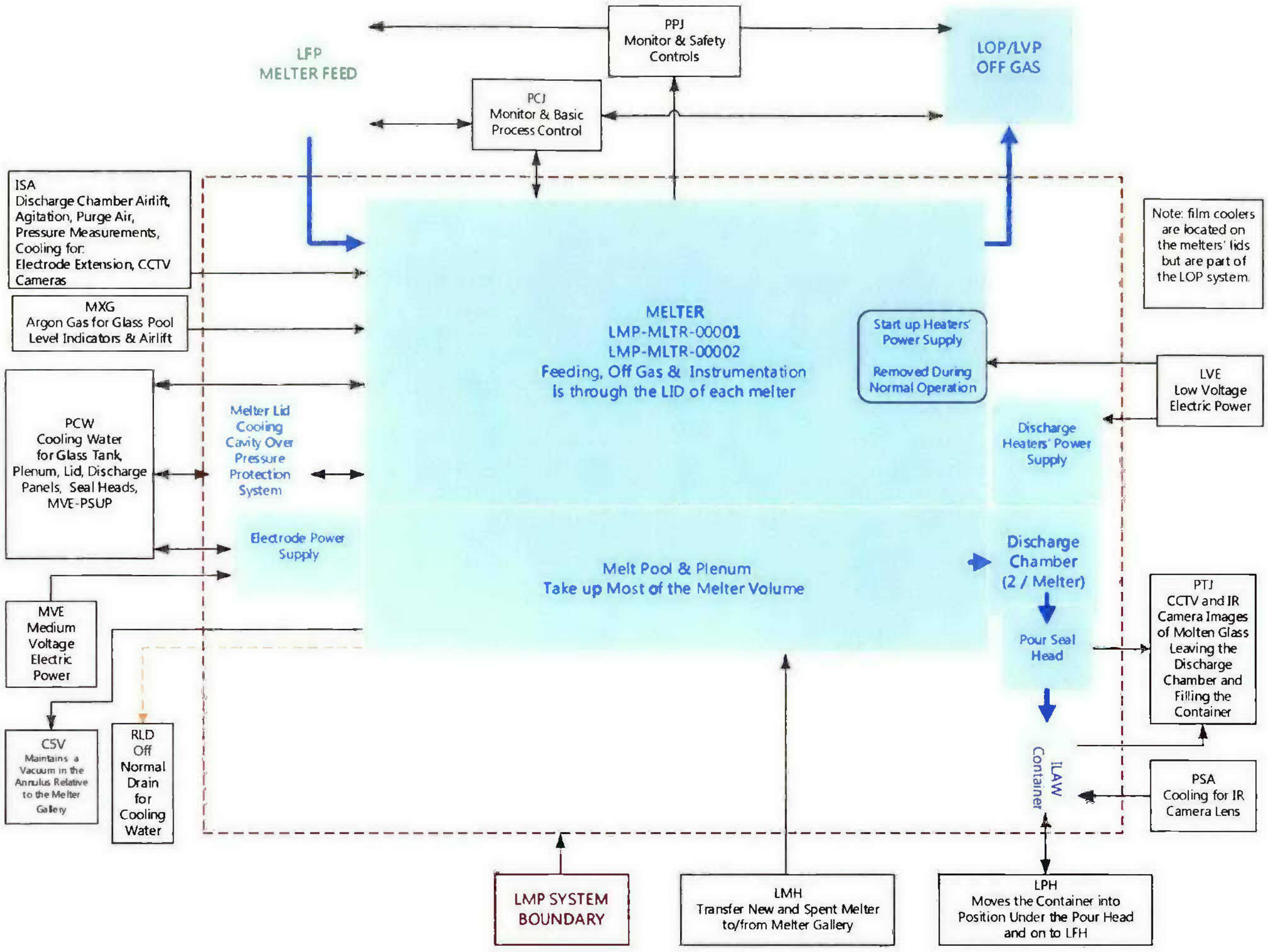


Figure 2-2 LAW Melter Simplified Process Flow Diagram

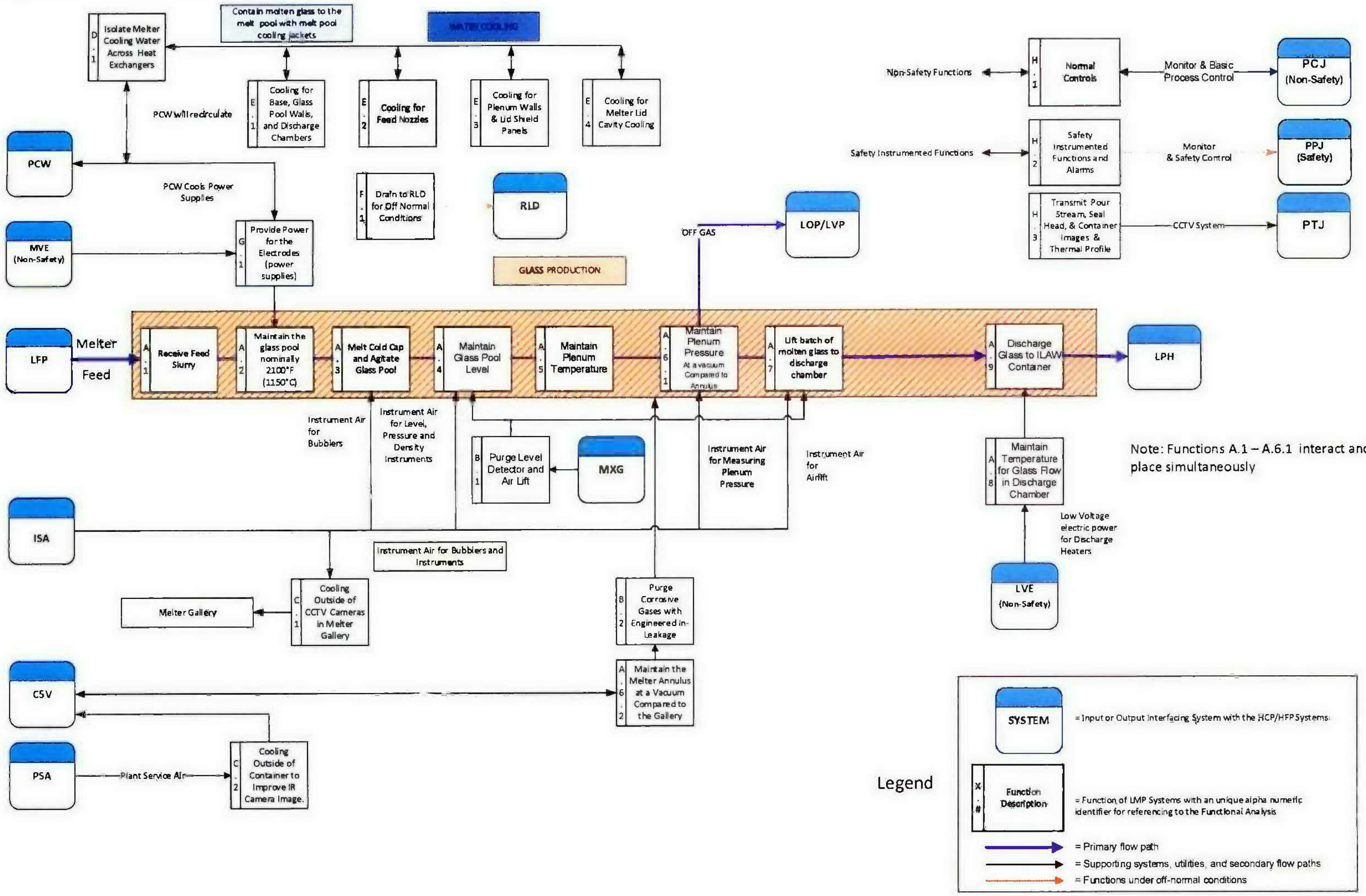


2.1 System Functions/Safety Functions

This section defines the LMP functions and attributes that need to be addressed by the system design. Figure 2-3 provides the functional block diagram for the LMP, indicating the internal and external system and utilities that provide the primary support or interface for that function. Section 3 provides the design and performance design requirements to meet both functional and other requirements.

System interfaces are provided for reference only. See Section 1.5.2 for the list of relevant system designators.

Figure 2-3 LMP Functional Block Diagram



The functions included in Figure 2-3 are the primary and secondary level functions of the LMP system. These functions are further described in Table 2-1. Where appropriate to support definition of functional and design requirements, functions have been further decomposed and additional levels of supporting functions are also described. The requirement section number provides the location of the applicable functional analysis incorporated into system requirements.

Appendix B provides a further decomposition of system functions, including initiating, terminating, and integrating events and functions.

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
A.	**GLASS PRODUCTION**	N/A
A.1	Receive feed slurry mixture of pretreated waste and glass-forming chemicals.	3.4.1.1
A.2	Maintain the nominal melt pool temperature of 2100 °F (1150 °C).	3.4.1.3, 3.14.1.1, 3.13.2.1, 3.14.1.2
A.3	Melt the cold cap and agitate the melt pool.	3.15.3.1
A.4	Maintain melt pool level.	3.5.2.2, 3.14.2.4.4
A.5	Maintain plenum temperature	3.14.2.4.2
A.6	Maintain a cascading ventilation system from the melter gallery to the melter annulus to the plenum.	3.5.2.1, 3.14.2.4.1,
A.6.1	Maintain a vacuum in the plenum relative to the annulus. The air pressures are maintained by LOP and C5V, LMP provides the gas barrier between the plenum and the annulus.	3.5.2.1, 3.14.2.4.1
A.6.2	Maintain the annulus as a C5V area, at a vacuum to the melter gallery. The air pressures are maintained by C5V and C3V. The LMP provides the melter enclosure which is a confinement barrier for C5V.	3.5.2.1
A.7	Lift molten glass to discharge chamber.	3.14.2.4.8
A.8	Heat discharge chambers.	3.12.1.1
A.9	Discharge Glass to ILAW container, Glass Production	3.4.1.2, 3.12.2.1
B.	**PURGING**	N/A
B.1	Purge level detectors and air lift with argon gas.	3.14.2.4.4, 3.14.2.4.8, 3.15.4.5
B.2	Purge corrosive gases away from melter structures and components with engineered in-leakage.	3.6.2.4
C.	**AIR COOLING**	N/A
C.1	Cooling the outside of the CCTV cameras (PTJ system components) with air from the ISA system.	3.14.3.3, 3.15.3.3
C.2	Cooling the outside of the container with air from the PSA system to improve the image produced by the IR camera.	3.14.3.1, 3.15.3.3
D.	**ISOLATE LAW COOLING WATER ACROSS HEAT EXCHANGER**	N/A
D.1	Isolate the LAW PCW from the BOF PCW.	3.11.1.1, 3.15.3.2
E.	**WATER COOLING**	N/A
E.1	Cooling for melt pool and discharge chamber cooling panels with PCW.	3.5.2.2, 3.11.1.2, 3.14.2.4.6

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
E.2	Cooling for feed nozzles with PCW.	3.15.2.2
E.3	Cooling for plenum, offgas ports and shield lid panels with PCW.	3.11.1.2, 3.11.1.3
E.4	Cooling for melter lid cooling cavity with PCW.	3.7.2.1, 3.14.2.1.2, 3.14.2.4.3
E.4.1	Maintaining cooling loop for melter lid cavity cooling below the PCW pressure.	3.8.2.1
F.	**DRAIN TO RLD**	N/A
F.1	Draining to the RLD in off-normal conditions.	3.11.2, 3.15.4.22
G.	**PROVIDE POWER TO THE ELECTRODES**	N/A
G.1	Power to the electrodes provided by the electrode power supplies.	3.13.4.1, 3.13.4.4
H.	**SUPPORT, MONITORING, AND COMMUNICATIONS FUNCTIONS**	N/A
H.1	**PCJ-Normal Controls**	N/A
H.1.1	The LMP nonsafety process shall be monitored and controlled by the PCJ system and shall include the following main functions: a) Monitor and control melt pool temperature. b) Monitor plenum pressure. c) Monitor plenum temperature. d) Monitor melter lid cooling cavity temperature. e) Monitor melt pool level and density. f) Monitor refractory temperature. g) Monitor cooling panel cooling water flow and temperature. h) Monitor feed encasement assembly leak detection. i) Control rate of discharge from melt pool to the discharge chambers. j) Monitor container fill level. k) Monitor and control electrode power supplies. l) Monitor and control startup heaters.	a) 3.4.1.3, 3.14.1.1 b) 3.5.2.1, 3.14.2.4.1 c) 3.14.2.4.2 d) 3.14.2.4.3 e) 3.14.2.4.4 f) 3.14.2.4.5 g) 3.14.2.4.6 h) 3.14.2.4.7 i) 3.14.2.4.8 j) 3.14.2.4.9 k) 3.4.1.3, 3.13.2.1, 3.14.1.2 l) 3.14.1.3
H.2	**PPJ – Safety Instrumented Functions and Alarms**	N/A
H.2.1	Shut down potential causes of melter pressure increase to prevent over pressurization of the melter.	3.14.2.1.1
H.2.1.1	Terminate melter feed upon detecting melter plenum high pressure (reduced vacuum).	3.14.2.1.1
H.2.1.2	Terminate air and demineralized water to the film cooler upon detecting melter plenum high pressure (reduced vacuum).	3.14.2.1.1
H.2.1.3	Open the standby offgas line upon detecting melter plenum high pressure (reduced vacuum).	3.14.2.1.1
H.2.1.4	Stop air supply to the WESP upon detecting melter plenum high pressure (reduced vacuum).	3.14.2.1.1
H.2.2	Prevent high melter lid temperatures to prevent against damage to the melter lid portion of the gas barrier plates and resulting (NOx) release via a breach to the melter offgas confinement boundary.	3.14.2.1.2
H.2.2.1	Terminate melter feed upon detecting melter lid cooling cavity cooling water high temperature	3.14.2.1.2

Table 2-1 Functional Analysis and Crosswalk to Requirements

Reference	Functional Analysis Description	Requirement Section No.
H.3	**PTJ – Mechanical Handling CCTV System**	N/A
H.3.1	Provide viewing of the pour stream through CCTV.	3.14.1.5
H.3.2	Transmit thermal profile of the container provided by the IR camera.	3.14.2.4.9
ADS = air displacement slurry; BOF = Balance of Facilities; CCTV = closed circuit television; DIW = demineralized water system; IR = infrared; PTJ = process and mechanical handling system; RLD = radioactive liquid waste disposal system		

2.2 System Classification

The LMP system contains components with the following classifications/designations:

- ☐ Safety Class
- ☒ Safety Significant
- ☒ Dangerous Waste Permit Affecting
- ☒ Air Permit affecting
- ☐ Waste Acceptance Impacting
- ☒ General

2.3 Basic Operational Overview

A functional system description is provided in Sections 2 and 2.1, which provides the context diagram for the system, interfaces with other systems, a simplified system diagram, a functional block diagram, and descriptions of the system functions. A basic operational system overview is described in this section. Detailed operational information is provided in Section 4.

There are three main operational functions of the LMP: to melt the glass and deliver it into the ILAW containers, to control the melter offgas flow, and to contain the molten glass within the boundary of the melter. The melting is described in Section 2.0. The interlock controls with the LOP, LVP and LFP systems maintain the plenum vacuum pressure and temperature and control the offgas flow. Cooling panels around the melt pool will freeze any molten glass that would seep through the refractory. Jack bolts push the refractory pieces together, minimizing routes for molten glass leaking.

A basic operational overview is provided in Section 4.0.

3 Design Requirements

3.1 Requirements

Requirements are documented in Sections 3.4 through 3.15. Each requirement statement is accompanied by a basis discussion (as needed) and the expected means of verification. Requirements must be met in design. If a requirement stated in this document cannot be met in design, a revision to the requirement needs to be pursued, if possible, or the design must be changed to meet the requirement.

Requirements preceded by "[**HOLD**]" may only be used in support of preliminary or committed design, which shall also be issued with appropriate holds per procedure 24590-WTP-3DP-G04B-00046, *Engineering Drawings*. These requirements may not be used in support of fabrication or construction.

The following abbreviations are used to designate the selected method for verification (see 24590-WTP-GPG-ENG-0161, *Technical Requirements Management*, for additional guidance concerning methods of verification):

(I)	Inspection
(A)	Analysis
(D)	Demonstration
(T)	Test

The following abbreviations are used to designate the organization responsible for performing the verification:

(ENG)	Engineering
(CON)	Construction
(SU)	Startup
(COM)	Commissioning
(SUP)	Supplier
(SUB)	Subcontractor
(SQR)	Supplier Quality Representative
(REC)	Receiving

3.2 Bases

Basis discussions are provided as needed to explain the decomposition or interpretation from the originating source requirement(s). Where a [**HOLD**] has been applied to a requirement, this section will include the basis for the "HOLD."

3.3 References

The requirements include a source document reference and a DOORS® Unique Identification Numbers (hereafter referred to as Identification Numbers or IDs). Each unique source document reference, with ID number(s), is bracketed separately. Requirements may include a reference to the Section 2.1, Functional Description, listed in parentheses following the source document and ID number references. A complete listing of all source references is provided in Section 5.

3.4 General Requirements

3.4.1 Mission and Functional / Performance Requirements

The following sections detail requirements for the LMP system design. These requirements are subject to verification as indicated. Where included, basis discussions provide supplementary information to help the reader understand the origin or intent of a requirement. Basis statements do not include requirements and are not to be considered requirements.

3.4.1.1 LMP Feed

Requirement: The LMP system shall receive a slurry mixture of pretreated waste and glass-forming chemicals from the LFP system at a feed rate to support melter design capacity. [Sections 15.3.1, 15.3.3 BOD, [ID : DB-ENG-01-001 ID#12690], [ID : DB-ENG-01-001 ID#12700], [ID : DB-ENG-01-001 ID#12700]] (A.1)

Basis Discussion: Recipes for the seven LAW slurry mixtures are given in Attachment 10.2 of 24590-LAW-MVC-LFP-00001, *LAW Melter Feed Process System (LFP) Data.* Information on modeling of batch sizes from the LFP to LMP is given in Section 6.3.2 of 24590-WTP-DB-ENG-01-001, *Basis of Design.*

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the feed rate required for the different LAW mixtures to meet the LMP design production capacity and LMP commissioning demonstration capacity.	See Section 3.4.1.2 of this SDD for LMP design capacity and commissioning capacity.
I	ENG	Review design to verify LMP is capable of receiving a slurry feed from the LFP system at the required feed rate to support the LMP design capacity.	
D	SU/ COM	Perform a demonstration to verify melter feed can be transferred from the LFP system to the melters at a feed rate that will support the LMP commissioning demonstration capacity.	

3.4.1.2 Production Rate

Requirement: The LMP shall produce glass at a rate of 30 MTG/day. [Sections 6.1.2, 6.3.2, 15.3.2, BOD, [ID : DB-ENG-01-001 ID#10311], [ID : DB-ENG-01-001 ID#10346], [ID: DB-ENG-01-001 ID # 10348], [ID : DB-ENG-01-001 ID#12697]] (A.9)

Basis Discussion: The LAW facility system supports operation of the LAW facility at a design capacity of up to 30 MTG/day including melter power supplies, pour cave cooling, and support for additional bubblers as necessary. Each of the two LAW melters has a baseline design capacity of 15 MTG/day. The LMP throughput will be a function of feed characteristics in a given batch. The LMP system also has capacity for a third melter.

The WTP contract, DOE 2000, requires testing to be performed during cold commissioning and hot commissioning to verify a reduced production rate of 18 MTG/day can be accomplished.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Review the throughput of the melter system to verify 2 melters operating concurrently will produce at least 30 metric tons of glass in a 24 hour period under normal operating conditions.	Discuss possible bottle necks in pour handling operations with operations. Some documentation may be in pilot tests.
T	SU/ COM	Perform an integrated test to verify the combined output for the LAW melter system can produce a minimum of 18 MTG/day during cold commissioning over a 20 day period.	Performed per WTP Contract, DOE-2000 Section C, Standard 5
T	SU/ COM	Perform an integrated test to verify the combined output for the LAW melter system can produce a minimum of 18 MTG/day during hot commissioning over a 20 day period.	Performed per WTP Contract, DOE 2000, Section C, Standard 5

3.4.1.3 Operating Temperature

Requirement: The melters shall maintain a nominal melt pool temperature of 2100 °F (1150 °C). (A.2), (H.1.1.a), (H.1.1.k)

Basis Discussion: In descriptive text, the-BOD calls for a temperature of approximately 2100 °F (1150 °C). Section 3.2.3.4 of the 24590-WTP-PL-RT-03-001, *ILAW Product Compliance Plan* calls for the glass to be between 1050 °C – 1200 °C to destroy free liquids, pyrophoric or explosive materials, and explosive and toxic gases.

The nominal melt pool temperature is a functional requirement based off of an operational requirement in the WTP Contract, DOE 2000, that the LAW glass meet Specification 2 of the WTP Contract, DOE 2000. Specification 2 requires that the melter process "destroy free liquids, pyrophoric or explosive materials, and explosive and toxic gases."

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Review the joule heating capacity of the electrodes and review the heat capacity of the melter feed to verify the melt pool can be maintained at nominal temperature of 2100 °F (1150 °C).	
T	SU/ COM	Perform a test during commissioning to verify the joule heating system is capable of raising the melt pool to a nominal temperature of 2100 °F (1150 °C).	The average temperature will be taken across the thermocouples submerged in the melt pool.

3.4.1.4 Design (Operating) Life

Requirement: Except as noted in Table 3-1, nonreplaceable, permanent LMP plant equipment shall be designed for a minimum design life of 40 years, inclusive of maintenance. All non-maintainable items of LMP system equipment shall last the life of the facility (40 years). Design life of equipment shall consider the effects of chemical, radiological, and thermal exposure. [Sections 11.1.1, 11.7.4, 11.8.3, 15.3.1, BOD, [ID : DB-ENG-01-001 ID#11367], [ID : DB-ENG-01-001 ID#11368], [ID : DB-ENG-01-001 ID#11528], [ID : DB-ENG-01-001 ID#12693]]

Table 3-1 LMP Equipment and Components Design Life

Equipment/Component Description	Design Life (Years)
Startup thermocouples	N/A
Startup heaters	N/A
Bubblers (with thermocouples)	2 Months
Melt pool and plenum thermocouples	2 Months
Glass level detector	9 Months
Refractory thermocouples	1.0
Electrode extension thermocouples	1.0
Discharge chamber thermocouples	1.0
Air lift lance	1
Lid plugs	5
Electrode extension cooling air exhaust thermocouples	5
Feed nozzles	5
Melter viewing camera	1.0
Melter view port	6 Months
Film cooler transition piece	1.0
Discharge thermowell	2.5
Discharge lid assemblies (heaters and lid)	2.5
Gas barrier, annulus and glass leak detectors	5
Melter shell	5
Cooling panels	>5
Jack bolts	>5

Basis Discussion: Equipment and material selection is based on proven performance, value engineering principles, and fit-for-function principles. The selection of equipment and materials is further addressed in detail as the design progresses. Equipment design needs to consider the routine environmental exposures under normal operations for non-safety equipment; safety and PAM equipment also considers abnormal and emergency exposures—this minimizes the need for equipment maintenance, exposure, and radiological waste generation in radiological areas.

Bubblers, thermocouples and melt pool level and density detectors have a much shorter design life because they are inserted directly into the corrosive environment of the melt pool and plenum. The design life of these components are predicted in Duratek's report (24590-101-TSA-W000-0010-409-1137, *95% Design Report-LAW Melter Life Report*).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	The "qualified" design life verification for safety and PAM SSCs is to be verified through review of equipment design as documented in equipment qualification packages.	Design life for safety and PAM equipment to be documented in equipment qualification packages.

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design to verify design life of non-replaceable, non-maintainable SSCs is documented in procurement documents and supported by supplier certificates of conformance.	May be documented in an assessment/evaluation.

3.4.1.5 Room Environment Conditions for Nonsafety Structures, Systems, or Components

Requirement: Nonsafety equipment/components located outside of the melter enclosure shall operate and withstand the service conditions per Table 12-1 in the BOD. [Table 12-1, BOD, [ID : DB-ENG-01-001 ID#13180]].

Basis Discussion: Nonsafety SSCs are designed to function as intended in the room environment conditions associated with their location. As stated in section (3.11.1.2) of this SDD, there is a requirement for the cooling loops to maintain the melter enclosure surface temperature low enough, approximately 95 °F (35 °C), to ensure personnel safety when accessing in melter. This limit on the surface temperature of the melter enclosure also maintains the melter gallery within the environmental limits listed in Table 12-1 in the BOD.

No upper level documents give requirements on conditions for SSCs inside of the melter enclosure. Estimated temperature conditions for the inside of the melter are listed in 24590-101-TSA-W000-0010-42-02, *Report - LAW Melter Materials Selection.* An estimate of the radiation environment inside of the melter is given in 24590-101-TSA-W000-0010-42-02, Rev. B, *Report - Law Melter Materials Selection.*

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review of design of nonsafety SSCs to ensure compliance with BOD, Table 12-1 conditions.	Documented in an evaluation/assessment report.

3.4.1.6 Materials of Construction and Erosion/Corrosion Design Parameters

Requirement: The LMP system shall include allowance for erosion/corrosion and use of materials of construction for the fluid service conditions and life expectancy that is identified in Section 3.4.1.4 of this SDD. [Section 11.9, BOD, [ID : DB-ENG-01-001 ID#11572], [ID : DB-ENG-01-001 ID#11572]]

Basis Discussion: The allowance for erosion/corrosion and applicable materials of construction are limited to those components that come into contact with the process fluids and that are required to maintain confinement/containment of those process fluids. Materials of construction that can withstand the erosive/corrosive low-activity waste effluents and chemicals are selected. The materials for the LAW Facility LMP system equipment and components should be selected based on the stream data presented in the process corrosion data sheet report. If vessel washing via internal spray mechanisms is needed to prevent or minimize corrosion, the operational limitation shall be identified in the vessel corrosion evaluation. Refer to Tables B-18, B-19; 24590-WTP-DB-PET-09-001, *Process Inputs Basis of Design* (PIBOD); and 24590-WTP-M4C-V11T-00024, *WTP Process Flowsheet Mass & Energy Balance Analysis for Input to Material Selection Assessments,* for the fluid characteristics of the process streams.

Details of the allowed materials and corrosion allowances can be found in:

- 24590-LAW-N1D-LMP-00001 LMP-MLTR-00001 & LMP-MLTR-00002 - *LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels*
- 24590-LAW-N1D-LMP-00002 LMP-TK-00001 & LMP-TK-00002 (PTF) - *Corrosion Evaluation - Melter 1 & Melter 2 Lid Cooling Loop Makeup Water Tanks*

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Perform an analysis/inspection of materials used in the LAW Facility the LMP system which are in contact with, and are required to maintain confinement or containment of, the process fluids to verify that they are acceptable for use in the operating environment and have adequate erosion and corrosion allowances.	Materials initially chosen for the design are listed in Section 4.2 of 24590-101-TSA-W000-0010-42-02, *Report - LAW Melter Materials Selection*. 24590-LAW-3PS-AE00-T0001, *Engineering Specification for the Low Activity Waste Melters* provides corrosion allowance for the melter gas barrier, lid, and cooling panels inside of the gas barrier.
I	ENG	Review design components used in the LAW Facility LMP system which are in contact with, and are required to maintain confinement or containment of, the process fluids for concurrence with analysis.	

3.4.1.7 Materials of Construction Thermal and Radiation Environment

Requirement: The design shall specify material for refractory as well as metal sections on the melter shell and discharge chamber that have been proven to withstand the radioactive, and thermal environment caused by the melter feed, glass, and offgas. [Sections 15.3.1, 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12695], [ID : DB-ENG-01-001 ID#12702]]

Basis Discussion: This requirement relates to the requirement in Section 3.4.1.5 of this SDD, Room Environment Conditions for Nonsafety SSCs, but the BOD goes on to specify the unique environmental conditions of materials in direct contact with the molten glass and offgas.

The plenum refractory will be the most susceptible to swings in the thermal environment. The melt pool's and discharge chambers' temperatures will remain fairly stable while the plenum's temperature is predicted to swing between 1100 °C and 400 °C (2012 °F to 752 °F) depending on feed rates and feed material. The plenum refractory is proven to resist thermal shock by splashed feed and offgas.

Tests have been performed on thermal and radiation effects on melter and consumable materials of construction and are documented in Section 4.2 of 24590-101-TSA-W000-0010-42-02, *Report - LAW Melter Materials Selection.*

Section 4.1.1.3 of 24590-101-TSA-W000-0010-42-02, *Report - LAW Melter Materials Selection*, states that radiation in the LAW melter is low enough that it will have no impact on the metal, refractory or plastics used in the construction of the melter.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Perform an analysis/inspection of material designated for the refractory and metal sections on the melter shell and discharge chamber to verify the material is acceptable for use in the thermal and radiation environment in which it will be used.	Materials initially chosen for the design are listed in Section 4.2 of (24590-101-TSA-W000-0010-42-02, Report - LAW Melter Materials Selection).

3.4.1.8 Seismic Design

Requirement: The LMP system equipment, including PAM, shall be designed and qualified for seismic conditions in accordance with Table 3-2 below. [Sections 4.4.2.3, 4.4.8.3, 4.4.13.2, 4.4.19.3, 4.4.26.3, 4.4.27.3, Table 3A-7, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11760], [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#12045], [ID : WTP-PSAR-ESH-01-002-03 ID#12306], [ID : WTP-PSAR-ESH-01-002-03 ID#12327], [ID : WTP-PSAR-ESH-01-002-03 ID#11022], [ID : WTP-PSAR-ESH-01-002-03 ID#13125], [ID : WTP-PSAR-ESH-01-002-03 ID#13120], [ID : WTP-PSAR-ESH-01-002-03 ID#11031], [ID : WTP-PSAR-ESH-01-002-03 ID#13126], [ID : WTP-PSAR-ESH-01-002-03 ID#13127], [ID : WTP-PSAR-ESH-01-002-03 ID#11001], [ID : WTP-PSAR-ESH-01-002-03 ID#13123]] [Section 11.7.3, BOD, [ID : DB-ENG-01-001 ID#11524]]

Table 3-2 LAW Melter Process System Seismic Design Categories

Description	Seismic Category	Reference
Melter shell	SC-III	Table 3A-7,4.4.2.3, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11022], [ID : WTP-PSAR-ESH-01-002-03 ID#11759]
Flow limiting valves in cooling water supply and return lines to the cooling jacket of the melter feed nozzles.	SC-III	Table 3A-7, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11031], [ID : WTP-PSAR-ESH-01-002-03 ID#12045], [ID : WTP-PSAR-ESH-01-002-03 ID#12048]
Pressure safety valves in melter lid cavity cooling water circuit credited to prevent melter lid cooling cavity over pressurization.	SC-III	Table 3A-7, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#13125]
Flow-limiting orifices in the PCW makeup lines to the melter lid cooling cavity surge tanks.	SC-III	Table 3A-7, PDSA - LAW [ID : WTP-PSAR-ESH-01-002-03 ID#13126]
Melter lid cooling system surge tanks.	SC-III	Table 3A-7, 4.4.26.3, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#13120], [ID : WTP-PSAR-ESH-01-002-03 ID#12306]
Overflow lines from melter lid cooling system surge tanks.	SC-III	Table 3A-7, PDSA - LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#13127]
LMP sensing and transmitting elements for high plenum pressure.	SC-III	Table 3A-7,4.4.8.3, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11001], [ID : WTP-PSAR-ESH-01-002-03 ID#11952]
LMP sensing and transmitting elements for high temperature in melter cooling lid cooling cavity.	SC-III	Table 3A-7, 4.4.27.3, PDSA – LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12327], [ID : WTP-PSAR-ESH-01-002-03 ID#11001]

Table 3-2 LAW Melter Process System Seismic Design Categories

Description	Seismic Category	Reference
Anchorages for utility lines that are of sufficient size and located such that they could affect the function of SS equipment in a seismic event.	SC-III	Table 3A-7, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#13121]
Anchorages for cable trays located above SS equipment or piping	SC-III	Table 3A-7, PDSA - LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#13123]

Basis Discussion: 24590-WTP-PSAR-ESH-01-002-01, *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information*, states "All components and parts of the equipment that provide or contribute to the safety functions and accident monitoring functions, including equipment supports and anchorage, shall be qualified accordingly." This qualification ensures SSCs meet the designated seismic design requirements. Safety Criterion 4.1-3 in the safety requirements document (SRD) details the equivalence of the WTP seismic category to the seismic performance category of DOE-STD-1020-94, *Natural Phenomena Hazards Design and Evaluation Criterial for Department of Energy Facilities.* The SRD also states that SSCs designated as safety SSCs withstand the effects of natural phenomena hazard events (e.g., earthquakes, wind, and floods) without loss of capability to perform specified safety functions.

Note on surge tank inclusion in Table 3-2, PDSA-LAW Section 4.4.26.3, [ID : WTP-PSAR-ESH-01-002-03 ID#12306] states that while the surge tank is SC-III due to adverse interaction potential, it is not classified as SS as it does not play a support function for the overflow line's safety function.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG/ SUP	Analysis or test performed on equipment listed in Table 3-2 to demonstrate capability to withstand seismic event.	This is expected to be documented in the equipment qualification packages.
I	ENG	Review design to verify conformance to the as-tested/as-analyzed configuration.	May be accomplished by equipment qualification packages or separate assessment.

3.4.1.9 Seismic Design Loads

Requirement: The melter shell and other SC III SSCs listed in Table 3-2 shall operate under seismic load conditions specified in 24590-WTP-DC-ST-04-001, *Seismic Analysis and Design Criteria.* [Section 15.3.4, BOD, [ID : DB-ENG-01-001 ID#12708]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify the design meets load requirements specified in 24590-WTP-DC-ST-04-001.	

3.4.1.10 Seismic Design for Interaction Effects

Requirement: Interaction effects shall be considered when determining the seismic category of individual items and, where an adverse seismic interaction with safety significant (SS) equipment exists, adequate measures shall be taken to preclude the adverse interaction. [Criterion 4.1-3, SRD, [ID : SRD-ESH-01-001-02 ID#1519]] [Section 10.2.15, BOD [ID : DB-ENG-01-001 ID#13213]]

Basis Discussion: Equipment that is non-safety may be identified as having a potential for adverse interaction with safety equipment during a seismic event in accordance with 24590-WTP-GPG-ENG-033, *Evaluation for Seismic Interaction Effects*. Where a resolution strategy is selected to increase the seismic category of the source SSC to protect the safety (target) SSC, the resulting seismic category of the equipment may be greater than SC-IV. In those cases, the equipment design is verified to meet the higher seismic performance category such that the target SSC is protected.

Based on 24590-WTP-PSAR-ESH-01-002-01, *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information*, seismic category IV piping are categorized as follows: i) non-safety piping and without an inventory of radioactive or hazardous material, but require seismic protection. ii) safety piping, but without seismic safety function. In accordance with 24590-WTP-GPG-M-036, Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts, seismic category IV are SSCs that do not provide primary confinement of significant inventories of radioactive materials. Seismic category IV includes non-safety SSCs that required seismic protection per the Uniform Building Code (UBC).

As discussed in 24590-WTP-PSAR-ESH-01-002-01, *Preliminary Documented Safety Analysis to Support Construction Authorization; General Information*, Seismic Category V piping does not require any seismic consideration. Seismic Category V items include lockers, bicycles racks, desks, etc. per 24590-WTP-GPG-M-036, *Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts.*

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Perform an evaluation of the LAW Facility LMP system to verify seismic categorization of equipment based on interaction effects per 24590-WTP-GPG-ENG-033 and devise a control strategy for all open interactions.	
A/T	ENG/ SUP	Analysis or testing performed on SSCs to demonstrate the ability to withstand the seismic loadings for their respective seismic categories to the extent necessary to prevent interactions.	Documented in an equipment seismic qualification review or supplier seismic design report.
I	ENG	Review design to verify conformance to the as-tested/as-analyzed configuration.	

3.4.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.4.2.1 Safety Designations

Requirement: The SSCs shall be designated as safety SSCs in accordance with Table 3-3. Structures, systems, and components designated as safety SSCs shall be designed, fabricated, erected, constructed, tested, inspected, and maintained to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. [Safety Criterion 4.1-2, 4.1-3, 4.4-1, SRD, [ID :

SRD-ESH-01-001-02 ID#35], [ID : SRD-ESH-01-001-02 ID#1519], [ID : SRD-ESH-01-001-02 ID#53]], [Sections 4.4.2.1, 4.4.8.1, 4.4.13, 4.4.17.1, 4.4.26.1, 4.4.27.1, 4.4.27.5, 4.4.28.1, Appendix 4A PDSA - LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#11755], [ID : WTP-PSAR-ESH-01-002-03 ID#11946], [ID : WTP-PSAR-ESH-01-002-03 ID#12040], [ID : WTP-PSAR-ESH-01-002-03 ID#12300], [ID : WTP-PSAR-ESH-01-002-03 ID#12112], [ID : WTP-PSAR-ESH-01-002-03 ID#12321], [ID : WTP-PSAR-ESH-01-002-03 ID#12342], [ID : WTP-PSAR-ESH-01-002-03 ID#12335], [ID : WTP-PSAR-ESH-01-002-03 ID#13535], [ID : WTP-PSAR-ESH-01-002-03 ID#13574], [ID : WTP-PSAR-ESH-01-002-03 ID#13536], [ID : WTP-PSAR-ESH-01-002-03 ID#13587], [ID : WTP-PSAR-ESH-01-002-03 ID#13588], [ID : WTP-PSAR-ESH-01-002-03 ID#13565], [ID : WTP-PSAR-ESH-01-002-03 ID#13589]]

Note: Safety instruments are also addressed separately in Section 3.14.2.

Table 3-3 LMP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class (SC)	Safety Significant (SS)	References	
				Safety Class (SC)	Safety Significant (SS)
Melter shell	Preserves the ability of the plenum to direct offgas into offgas system piping, and prevents NOx generating material from reaching the melter enclosure. Prevents leakage of bulk glass in the case of a refractory failure.	No	Yes	N/A	Section 4.4.2.1, Table 4A-2, PDSA - LAW
Feed nozzle cooling water flow valves	Limits the maximum allowable flow of water to the melter feed nozzle cooling jackets. This safety function ensures that in the event of a cooling jacket breech, steam excursion in excess of the capability of the melter and offgas system to accommodate, resulting in a blockage of the offgas flow path, will not occur.	No	Yes	N/A	Section 4.4.13, Table 4A-2, PDSA - LAW
Melter lid cooling cavity	Provides adequate cooling of the melter lid plate that forms the top of the melter plenum gas barrier during normal operation, and limits the rate of temperature increase of the plate in the event of loss of cooling flow or function.	No	Yes	N/A	Section 4.4.27.1, Table 4A-2, PDSA - LAW
Pressure safety valves (Melter lid cooling cavity overpressure protection)	Prevents the melter lid cooling cavity from exceeding its design pressure as a result of failure of the interface between the melter lid cooling water system and the PCW system. This safety function protects the melter lid plate. Over pressurization of the melter lid cooling cavity can result in the failure of the melter lid plate and introduce excess cooling water into the melter. Introduction of excess water into the melter can result in steam pressurization and loss of melter confinement.	No	Yes	N/A	Section 4.4.26.1, Table 4A-2, PDSA - LAW
Restricting orifice on the makeup water line (Melter lid cooling cavity overpressure protection)	Limits flow to the surge tank in the melter lid cooling water circuit to below the capacity of the tank overflow to ensure the surge tank is not a source of pressurization for the melter lid cooling cavity.	No	Yes	N/A	Section 4.4.26.3, Table 4A-2, PDSA - LAW

Table 3-3 LMP Safety Designations

Equipment/ Component Description	Safety Function	Safety Class (SC)	Safety Significant (SS)	References	
				Safety Class (SC)	Safety Significant (SS)
Surge tank overflow line (Melter lid cooling cavity overpressure protection)	Works in conjunction with the flow restricting orifice to limit flow to the surge tank in the melter lid cooling water circuit to below the capacity of the tank overflow to ensure that the surge tank is not a source of pressurization for the melter lid cooling cavity.	No	Yes	N/A	Section 4.4.26.3, Table 4A-2, PDSA - LAW
Melter lid cavity high temperature interlock	Prevents excessive melter lid cooling cavity temperatures from resulting in a melter offgas release.	No	Yes	N/A	Section 4.4.27.5, Table 4A-2, PDSA- LAW
Melter plenum pressure interlock	Prevents excessive melter plenum pressure from resulting in an offgas release.	No	Yes	N/A	Section 4.4.8.1, Table 4A-2, PDSA- LAW
Splash protection devices for SS SSCs located in pressure relief pathways	Prevent damage from water splashing above where SS SSCs are located under pressure relief pathways.	No	Yes	N/A	Section 4.4.28.1, Table 4A-2, PDSA- LAW
Through penetrations of fire barriers by LMP components.	Provide a fire safety barrier.	No	Yes	N/A	Section 4.4.17.1

Basis Discussion: To ensure safety SSCs meet the design functions, Safety Criterion 4.4-1 of the SRD states: "Safety structures, system, and components designated as Safety Class and Safety Significant shall be designed and qualified to function as intended in the environments associated with the events for which they are intended to respond."

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify inclusion of correct safety designation and function(s) as identified by the equipment qualification data sheets.	May be accomplished by EQP and/or design verification report (DVR).

3.4.2.2 Room Environment Conditions for Safety SSCs

Requirement: The safety SSCs in the LAW Facility LMP system credited with a safety function(s) and post accident monitoring instruments (24590-LAW-RPT-ENS-12-001, *LAW Post Accident Monitoring Report*) shall be designed and qualified to perform their safety function(s) as intended in the environment conditions associated with the events for which they are intended to respond, inclusive of aging effects throughout their qualified life. [Safety Criterion 4.1-3, Safety Criterion 4.4-1, SRD, [ID : SRD-ESH-01-001-02 ID#53]] [Section 11.7.3, BOD, [ID : DB-ENG-01-001 ID#11524], [ID : DB-ENG-01-001 ID#11526]]

Basis Discussion: Safety SSCs designated as safety class (SC) or safety significant (SS) are designed and qualified to function as intended in the room environment conditions associated with the events for which they are intended to respond. The effects of aging on normal and abnormal functioning are considered in design and qualification. 24590-LAW-U0D-W16T-00001, *LAW Room Environment Data Sheet* identifies environmental conditions for rooms that house safety SSCs. Safety SSCs located inside of the melter enclosure are designed and qualified to function as intended in that environment. The equipment data sheets will list the environmental conditions for these safety SSCs.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/T	ENG	Perform analysis or testing to verify the ability of the SSCs credited with a safety function and post accident monitoring to withstand specified environmental conditions.	Document in EQP. See 2490-LAW-U0D-W16T-00001, LAW Room Environment Data Sheet for room environmental conditions for safety SSCs located outside of the melter enclosure. See equipment data sheets for safety SSCs located inside of the melter enclosure..
I	ENG	Review the design to verify conformance to the as-tested or as-analyzed configuration.	Document in an evaluation/assessment report or EQP.

3.4.2.3 Protection of Safety Equipment from Water Spray

Requirements: The SS instrumentation and electrical equipment shall be designed with appropriate National Electrical Manufacturers Association (NEMA) ratings to survive exposure to water sprays, where such instrumentation and electrical equipment is co-located near water lines. Equipment enclosures shall be suitable for the area classification, as defined in NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)* in which they are installed. [Section 16.1, ORD, [ID : WTP-RPT-OP-01-001 ID#1606]] [Sections 4.4.8.3, 4.4.27.3, 4.4.27.4, 4.4.27.5, PDSA – LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#11951], [ID : WTP-PSAR-ESH-01-002-03 ID#12326], [ID : WTP-PSAR-ESH-01-002-03 ID#12331], [ID : WTP-PSAR-ESH-01-002-03 ID#12293]]

Basis Discussion: The SS instrumentation and electrical components that could be exposed to a water spray from the nonseismic failure of nearby water lines (e.g., water lines that are not safety and have no intervening splash barriers) must experience the water spray without the facility losing the required safety function. This is accomplished by designing the equipment to survive exposure to water without loss of function. NEMA 250 is the applicable standard for those instruments and electrical components that must survive a water spray from nearby water lines without loss of safety function.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Determine which SS instruments and electrical equipment are subject to water spray based on the SSC proximity to nearby waterlines.	
I	ENG	Review design to verify that these instruments and electrical equipment are designed according to standard NEMA 250.	

3.4.3 System Interface Requirements

Requirements associated with specific system interfaces are discussed in the subsequent requirement sections titled "System Interface Requirements." The LMP interfaces are listed in Table 3-4.

Table 3-4 LAW Melter Process System Interfaces

System Locator	System Name	Nature of Interface
MXG	Miscellaneous gases system	Argon is used in air lift tube and level detectors.
C5V	C5 Ventilation	Maintains the annular space at negative condition relative to the C3 occupied area. Also provides air in-leakage to the melter.
GRE	LAW grounding grid	Grounds the melter.
ISA	Instrument service air	Provides purges on melter instruments, bubbler air, and cooling for PTJ cameras, LMP instrument enclosures, and electrode extensions.
LFP	LAW melter feed process	Blends radioactive waste with glass formers and transports the slurry to the LMP for vitrification.
LMH	LAW melter handling	Used to move the melter in and out of the facility with a winch system consisting of pulley blocks mounted in the facility and on the melter base. (The seismic anchors, melter wheels, guide rollers, melter transporter, and transition doors are also considered part of this system.)
LOP	LAW melter primary offgas	Pulls offgas up from the plenum region of the melter and begins the process of cleaning the offgas so it can be released to the atmosphere. The LOP provides pressure control for the melter.
LPH	LAW container pour handling	Positions empty containers below the melter discharge chamber. The LPH system is primarily composed of the container turntable and the elevator for handling empty and full containers.

Table 3-4 LAW Melter Process System Interfaces

System Locator	System Name	Nature of Interface
LSH	LAW melter equipment support handling	Provides equipment and support necessary to complete maintenance tasks on all melters and equipment in the melter gallery of the LAW Facility. The system also provides for the methods, equipment, and packaging needed for bubbler replacement and removal of melter consumables.
LVE	Low voltage electrical	Provides power to melter discharge and startup heater power supplies.
LVP	LAW secondary offgas system	Processes melter offgas downstream of the LOP. In some cases, interlocks with the LOP will affect the plenum pressure in the LMP.
MVE	Medium voltage electrical	Provides power to melter electrode power supplies.
PCJ	Process control system	Provides monitoring and control functions for non-safety instruments and equipment. Provides status displays of safety instruments.
PCW	Plant cooling water	Supplies cooling water for areas inside of the melter as well as for the LMP medium voltage power supplies.
PPJ	Programmable protection	Provides monitoring and automatic control functions for safety instruments and equipment
PSA	Plant service air	Provides air to cool the IR camera lens to improve the accuracy of the thermal profile.
PTJ	Process and mechanical handling CCTV system	Provides means for remotely viewing and monitoring of the plenum area and the pour stream. The PTJ also transmits a thermal profile of the LAW container and an electrical input of the container level so the container level can be determined as the container is being filled with molten glass.
RLD	Radioactive liquid waste disposal system	Provides a drain for cooling water discharge from the melter for off normal conditions.

3.4.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.4.4.1 Loadings in Addition to Seismic

Requirement: The melters shall withstand static loads including the weight of the structures, permanent equipment, piping, circulated fluids, ventilation and cooling piping, molten glass, refractory, and loads due to relative thermal expansion. [Section 15.3.4, BOD, [ID: DB-ENG-01-001 ID#12710]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis of all applicable loads for each structural component of the melter to verify the melters can withstand static loading per the requirement.	
I	ENG	Review design to verify conformance to analysis.	Document in evaluation/assessment.

3.4.4.2 Deflection Under Load

Requirement: The melter design shall accommodate limited transport from an assembly area to its installed location without being damaged. [Section 15.3.4, BOD, [ID : DB-ENG-01-001 ID#12707]]

Basis Discussion: The bricks in the melter refractory are very precisely placed. Too much deflection in the melter base or melter shell during transport could cause a shift in the bricks. In addition, deflections in the melter shell and melter base caused by thermal expansion/contraction or other reason could cause movement of the refractory bricks during normal operation.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to determine the maximum amount of deflection in structural components that the refractory can withstand.	
I	ENG	Review the design to verify that the maximum deflections structural components are expected to experience during the transport to the assembly area are low enough so as to not disturb the refractory.	

3.5 Confinement of Radioactive and Hazardous Materials

3.5.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.5.1.1 Locally Shielded Melter – Radiation Confinement

Requirement: The LAW melter shall be a locally shielded melter, LSM; the melter enclosure will provide radiation shielding to allow for safe personnel access to the top and sides of the melter enclosure. [Sections 15.3.3, 15.3.5, 12.3.2, BOD, [ID : DB-ENG-01-001 ID#12704], [ID : DB-ENG-01-001 ID#12714], [ID : DB-ENG-01-001 ID#11627]]

Basis Discussion: The LAW melter is designed to be contact handled, that is to allow workers to monitor instruments placed just outside of the melter enclosure and install and remove consumable components by hand (with the help of the LAW melter equipment support handling system (LSH) crane for heavier components). The radiation shielding provided by the enclosure allows this close access to the melter. The melter gallery is rated as an R3 area (see drawing 24590-LAW-P1-P01T-00002, *LAW Vitrification Building General Arrangement Plan at EL. 3 FEET-0 Inches*) so the verification that the melter enclosure is providing safe personnel access to the gallery is to verify the workers in the gallery receive doses at or below those expected in an R3 area.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Determine the amount of shielding required by the melter enclosure for workers in the melter gallery and standing on top of the shield lid to receive radiation dose rates at or below those expected for an R3 area.	Document in an evaluation/assessment. Rad Engineering to participate in and/or review the evaluation/assessment Refer to calculation: 24590-LAW-Z0C-20-00004, *LAW Melter Shielding*

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the melter enclosure design to verify workers in the melter gallery and standing on top of the melter shield lid receive radiation dose rates at or below those expected for an R3 area.	Document in an evaluation/assessment. Rad Engineering to participate in and/or review the evaluation/assessment

3.5.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.5.2.1 Confinement of Offgas

Requirement: The LMP shall operate under a cascading ventilation system and primary and secondary confinement zones that will direct plenum offgas into the LOP system. The melter shell provides the primary confinement boundary for the offgas. The melter enclosure shall provide the confinement boundary for the C5V ventilation in the annular space to prevent offgas excursions into the melter gallery, a C3V space. [Sections 8.1.4.2, , 15.1, ORD, [ID : RPT-OP-01-001 ID#1159], [ID : RPT-OP-01-001 ID#1574]] [Section 4.2-1, SRD, [ID : SRD-ESH-01-001-02 ID#40]] [Sections 4.4.2.1, 4.4.2.5, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11755], [ID : WTP-PSAR-ESH-01-002-03 ID#11764], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] [Sections 5.1.2, 12.3.1.1, 12.3.2, 15.3.3, BOD, [ID : DB-ENG-01-001 ID#10259], [ID : DB-ENG-01-001 ID#11595], [ID : DB-ENG-01-001 ID#11627], [ID : DB-ENG-01-001 ID#12705], [ID : DB-ENG-01-001 ID#12704]] [Sections III.10.I.1.c.ix, III.10.I.1.c.x, DWP, [ID : WA7890008967 WTP ID#525], [ID : WA7890008967 WTP ID#645]] (A.6), (A.6.1), (A.6.2), (H.1.1.b)

Basis Discussion: The offgas from the melting cold cap are directed to the LOP, preventing back flow into the melter gallery.

The LOP, LVP, C5V, C3V, melter shell and melter enclosure work together to set up a cascading ventilation system so the plenum will be at a lower pressure than the annular space, and the annular space will be at a lower pressure than the melter gallery. The melter shell and melter enclosure act as confinement barriers in this system. Neither the melter shell nor the melter enclosure are airtight. This allows air to be drawn into the plenum. See Section 3.6.2.4 of this SDD for air in-leakage requirements. The acceptable pressure difference between the annulus and melter gallery is given in Section 3.3.B.2 of 24590-LAW-3PS-AE00-T0001 as -2.0 inWC.

One way of controlling the ventilation is to inject air into the film cooler. The film cooler is part of the LOP system.

Specifications of relative vacuum pressures between the plenum, the annular space, and the melter gallery are given in Section 3.3.B.2 of 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters*. Specific requirements for the melter shell and melter enclosure are given in Sections 3.6 and 3.9 of this SDD.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/ COM	Perform testing to verify the annulus air pressure is at a vacuum relative to the melter gallery while the annulus air pressure is meeting the requirements of C5V system and the gallery air pressure is meeting the requirements of the C3V system.	**CTNs:** LMP-PDI-1412/1413 melter 1 and LMP-PDI-2412/2413 melter 2 measure the pressure difference between the annulus and the gallery for the PCJ system. These instruments are specified in DWP Permit Table IIII.10.H.C

Verif. Method	Verif. By	Plan	Notes/Comments
T	SU/ COM	Perform testing to verify the plenum pressure is at a vacuum relative to the annulus while the annulus air pressure is meeting the requirements of the C5V system. The acceptable pressure difference between the annulus and plenum is given in Section 3.3.B.2 of 24590-LAW-3PS-AE00-T0001, as -5.0 inWC.	**CTNs:** LMP-PDT/PDI -1410/1411, melter 1, LMP-PDT/PDI-2410/2411, melter 2 measure pressure difference between the plenum and the annular space for the PCJ system.

3.5.2.2 Containment of Bulk Glass

Requirement: Bulk glass shall be contained to the melt pool inside of the refractory under normal operating conditions. The melter shell shall be capable of containing bulk glass in the event of a refractory failure. [Section 15.1, ORD, [ID : RPT-OP-01-001 ID#1574]] [Section 4.4.2.3, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] [Sections 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12702], [ID : DB-ENG-01-001 ID#12704]] [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] (A.4), (E.1)

Basis Discussion: The melter shell, refractory, cooling panels and jackbolts form a containment system that contains the bulk glass to the interior of the melt pool. Jackbolts put pressure on the refractory to minimize openings between blocks of the refractory material, and cooling panels cool the outside of the refractory so that any bulk glass that migrates through the refractory solidifies before passing the melter shell into the annular space. The refractory is the primary containment for the bulk glass, the melter shell is secondary containment, and finally the melter enclosure is designed to contain a full melt pool from seeping into the melter gallery. Metallic plate dams prevent glass migration into the discharge chamber (24590-QL-HC4-W000-00094-03-00001, *LAW Melter Design Basis Report).*

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to confirm the melter shell is able to contain the bulk glass in the event of a refractory failure.	
A	ENG	Perform an analysis on the melter enclosure to verify it is capable of containing all of the molten glass from the melt pool.	
I	ENG	Verify the melter enclosure design agrees with the assumptions made in the analysis about the melter enclosure containing molten glass from the melt pool.	
D	SU/ COM	Demonstrate the melt pool will remain at a constant level while feeding and discharge operations are halted. (idle state)	A successful demonstration will show that no bulk glass is leaking beyond the refractory.

3.5.3 System Interface Requirements

3.5.3.1 Dedicated Offgas Systems

Requirement: Each melter shall be connected to a dedicated offgas system. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12703]]

Basis Discussion: The LMP produces offgas containing harmful and regulated constituents that need to be removed prior to releasing to the environment. The dedicated offgas system also maintains the melter plenum at a negative pressure to confine the offgas.

The BOD does specify that the melters' individual offgas systems will combine downstream of the wet electrostatic precipitation (WESP). The operation of LOP components upstream of the WESP, the air film coolers, and submerged bed scrubber (SBS) are interdependent with the plenum pressure and temperature of each melter and are also dependent on the individual melter feed rate and feed composition.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the each melter has a dedicated offgas system.	

3.5.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.6 Melter Shell

3.6.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.6.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirement

3.6.2.1 Anchored Melter Shell

Requirement: The melter shell shall be anchored to prevent motion during a SC-III event, and the shell will be fixed on the discharge chamber side of the melter. [Sections 4.4.2.3, 4.4.2.5, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#11768], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: The melter shell is designed to remain intact to provide a confinement boundary to direct offgas to the offgas system. Having the melter fixed on one side provides necessary seismic anchorage while also allowing thermal expansion on the other three sides of the melter. It is appropriate to have the melter shell fixed on the discharge chamber side to ensure the discharge trough and dam remain in a fixed position so they always line up with the pour spout. In addition, there is no access to jackbolts on the south side of the melter around the discharge chambers, so the melter shell is fixed in that location to provide adequate support for the refractory in the discharge chambers. Anchoring the base of the melter shell may be accomplished via anchoring the base to the melter rails with anchor pins.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the design of the anchorage of the melter shell to verify no movement of the melter during a SC-III event.	Document in DVR.
I	SU/ COM	Verify the melter shell has been anchored per the design documents.	Document in an evaluation and assessment report.

3.6.2.2 Containment of a Steam Explosion inside the Melter Shell

Requirement: [HOLD] The melter shell shall maintain its confinement boundary following a steam explosion from a water sulfate layer interaction. [Section 4.4.2.3, 5.6.4, PDSA-LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: This requirement is on HOLD because there is currently no way of verifying it, as analysis has yet to show a credible accident scenario from a steam event. Nuclear Safety Engineering (NSE) has suggested performing a hazards analysis of the control selection process for the melter feed formulation process that would ensure the chemistry of the melter feed would prevent a chemistry in the cold cap that could produce a water sulfate steam explosion. The design should be identified as incomplete on any DCL, pending completion of the referenced ATS. This hold is being tracked by the WTP Action Tracking System, (ATS-MGT-15-0225).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
NA	NA	A verification plan cannot be developed at this time. This is the reason this requirement is on a [HOLD].	

3.6.2.3 Loads from Vacuum

Requirement: The melter shell and its structural supports shall withstand the maximum vacuum it will experience. [Sections 4.4.2.3, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: The design rating of a melter shell is such that it can withstand the vacuum which it can experience given the LVP system reconfiguration control and the LOP system reconfigurations that will occur as necessary from the individual melter offgas system interlocks. (4.4.2.5, PDSA-LAW).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the melter shell and supports capability to withstand the maximum vacuum which can occur given known LVP configurations.	Document in DVR. (The maximum vacuum for the melter is listed in Section 3.5.D.4 of 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters* ,as -40 inWC.)

3.6.2.4 Allowance for Air In-Leakage into the Plenum

Requirement: The melter shell shall include in-leakage paths to ensure adequate air will be drawn into the plenum to prevent potential offgas excursions from escaping into the melter gallery and to preclude flammable gas concentrations in the melter offgas system. A portion of this air in-leakage will come from the C5V ventilation into the plenum. [Section 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] [Sections 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12705]] (B.2)

Basis Discussion: Allowing for air leakage from the annular space in through the melter shell and out through the offgas system assists in the following:

- The cascading ventilation system.
- Precluding flammable gas concentrations in the plenum from reaching their lower flammability limit.
- Minimizing the likelihood of deposition of corrosive material on the refractory.

The anticipated rate of air in-leakage is provided in Section 6.1.11 of 24590-QL-HC4-W000-00094-03-00001, Rev 00A, *REPORT - LAW Melter Design Basis Report* as 400 scfm. This would be a combination of air entry to the melter through the bubblers, discharge chamber ventilation, standby film cooler injection air and standby offgas duct purges, and air input from the C5V into the annular space.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the LMP to determine the minimum amount of air in leakage to accomplish the functions listed in the requirement.	Refer to calculation, 24590-QL-HC4-W000-00094-05-00003 00A, *LAW Melter In-Leakage And Purge Flow Rates*
I	ENG	Review the design of the melter shell and existing air supplies to the melter shell to verify there is sufficient air in-leakage to meet the requirements above.	Document in a DVR.
T	SU/ COM	Verify the minimum in-leakage flow determined by the analysis above occurs.	

3.6.3 System Interface Requirements

System interfaces with the GRE are listed in Section 3.15.3.4.

3.6.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.7 Melter Lid Cooling Cavity

3.7.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.7.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.7.2.1 Cool Gas Barrier Lid

Requirement: The melter lid cooling cavity shall maintain the gas barrier lid below its deformation temperature. [Sections 4.4.2.1, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11755], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] (E.4)

Basis Discussion: If the gas barrier lid is deformed due to overheating, confinement of the offgas is compromised. The melter lid cooling cavity provides cooling water to prevent overheating of the gas barrier lid.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the gas barrier lid to determine its deformation temperature.	Document in DVR.
A	ENG	Analyze the heat transfer from the gas barrier lid to the melter lid cooling cavity to determine the flow rate and temperature of the cooling water needed to keep the gas barrier from deforming due to high temperature.	Document in DVR.
I	ENG	Review the design to verify the melter lid cooling cavity keeps the gas barrier lid below a deformation temperature.	Document in DVR.

3.7.2.2 Prevent Water from the Cooling Cavity from Entering the Plenum

Requirement: Cooling water for the melter lid cooling cavity shall be prevented from entering the melt pool. [Sections 4.4.2.1, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11755], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: Cooling water from the melter lid cooling cavity leaking into the melt pool could cause excessive steam in the plenum, which could cause a surge in plenum pressure. The intent of the requirement is to prevent extra water entering the melt pool via the melter lid cooling cavity. Melter feed will contain between 36-40% water, see Attachment 10.2 of 24590-LAW-MVC-LFP-00001, LAW Melter Feed Process System (LFP) Data.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify water from the melter lid cooling cavity does not migrate into the plenum.	Document in DVR.

3.7.2.3 Elevated Piping Inlet and Outlet

Requirement: The piping inlets and outlets for the melter lid cooling cavity shall be elevated near the top of the cavity. [Section 4.4.2.3, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: The main purpose of the melter lid cooling cavity is to provide cooling water for the gas barrier lid. The melter lid cooling cavity sits directly on top of the gas barrier lid plates. However, it is also important to limit the loss of cooling water in the event of a leak in the system to limit the amount of water that could enter the melt pool. An excessive amount of water in the melt pool could lead to a surge in plenum pressure.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the piping inlets and outlet for the melter lid cooling cavity are located toward the top of the cavity so as to minimize the amount of cooling water that could reach the melt pool in the event of a cooling water line leak.	Document in DVR.

3.7.2.4 Design Guide

Requirement: ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, shall be used as a design guide for the LAW melter lid cooling cavity. [Section 4.4.2.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11762]]

Basis Discussion: ASME *Boiler and Pressure Vessel Code*, Section VIII, Divisions 1 and 2, shall be used as a guide for structural design and qualification. The lid is not required to meet all the requirements of ASME *Boiler and Pressure Vessel Code*, Section VIII. Exceptions taken to the code, if any, are documented in design calculations.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Determine what sections of ASME *Boiler and Pressure Vessel Code*, Section VIII, Divisions 1 is applicable to the design of the melter lid cooling cavity.	Document in a DVR.
I	ENG	Review the design to verify standards from applicable sections of ASME *Boiler and Pressure Vessel Code*, Section VIII, Divisions 1 is included in the design.	Document in a DVR.

3.7.3 System Interface Requirements

System interface between instrumentation in the melter lid cooling cavity and the PCJ and PPJ systems are listed in Section 3.14.

3.7.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.8 Over Pressure Protection, Melter Lid Cooling Cavity

3.8.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.8.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.8.2.1 General Requirement

Requirement: The melter lid cooling cavity shall have protection from over pressurization from the interfacing PCW loop to ensure the cooling water in the melter lid cooling cavity always operates at a pressure less than 15 psig. [Sections 4.4.2.5, 4.4.26.1, 4.4.26.2, 4.4.26.5, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11767], [ID : WTP-PSAR-ESH-01-002-03 ID#12300], [ID : WTP-PSAR-ESH-01-002-03 ID#12302], [ID : WTP-PSAR-ESH-01-002-03 ID#12312]] (E.4.1)

Basis Discussion: High pressure in the melter lid cooling cavity due to interfaces with the PCW closed loop cooling water system (e.g., breakthrough from the PCW system into the melter lid cooling system through the heat exchanger, or excessive makeup water flow from the PCW system to the melter lid cooling system surge tank) can result in the failure of the cavity and introduction of excess cooling water into the melt pool. The extra water in the melt pool could cause a melter surge or steam excursion in excess of the capability of the offgas system to accommodate. Water used for the melter lid cooling cavity circulates in a closed loop, separated from the PCW used for cooling panels by a heat exchanger. This loop has several over pressure protection measures, such as a vented surge tank and pressure safety valves.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the cooling loop in the melter lid cooling cavity is isolated from the PCW system, and the cooling loop operates under 15 psig.	Document in DVR.

3.8.2.2 Pressure Safety Valve Setting

Requirement: The cooling water circuit for the melter lid cooling cavity shall include pressure safety valves (PSV) set such that the melter lid cooling cavity does not exceed its design pressure. [Section 4.4.26.3, 4.4.26.5, PDSA- LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12305], [ID : WTP-PSAR-ESH-01-002-03 ID#12313]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the inclusion of the pressure safety valves.	Document in DVR
I	SU/ COM	Verify the pressure safety valves are set below the design pressure.	

3.8.2.3 Pressure Safety Valve Location

Requirement: The PSVs in the melter lid cooling cavity-cooling circuit shall be located closely downstream of the heat exchanger but upstream of the melter lid cooling cavity. [Section 4.4.26.5, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12313]]

Basis Discussion: This configuration mitigates the potential to isolate the pressure relief valve (PSV) from both melter lid cooling cavity and the heat exchanger in such a way to negate the protective function of the PSV. The heat exchanger in the requirement exchanges heat between the PCW loop for the cooling panels and the metal lid cooling cavity loop. One accident scenario for over pressurization involves a breach in this heat exchanger that would push the higher pressure PCW water into the melter lid cooling cavity loop. This configuration also protects against the over pressures that could be generated by the melter lid cooling cavity pumps.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design puts the PSVs in the correct location.	References: 24590-LAW-JVC-LMP-00002, Rev A, *LAW Melter Lid Cooling PSV Sizing* 24590-LAW-JVC-LMP-00003, Rev A, *LAW Melter Lid Cooling Heat Exchanger PSVs Sizing*

3.8.2.4 Pressure Safety Valve Designated Codes and Standards

Requirement: The PSVs on the melter lid cooling cavity cooling water loop used to maintain the cooling water at the design pressure shall be designed and manufactured according to ASME, *Boiler and Pressure Vessel Code*, Section VIII, Division 1. [Section 4.4.26.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12308]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify that the PSVs were designed and manufactured according to ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1.	Document in an EQP.

3.8.2.5 Vented Surge Tank

Requirement: Makeup water from the PCW for the melter lid cooling cavity cooling loop shall pass through a vented surge tank before entering the cooling cavity circuit. [Section 4.4.26.2, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12302], [ID : WTP-PSAR-ESH-01-002-03 ID#12303]]

Basis Discussion: By passing PCW water through the vented surge tank, the PCW makeup water is reduced to atmospheric pressure before entering the melter lid cooling cavity cooling water loop.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design puts the vented surge tank in the correct location.	

3.8.2.6 Overflow Line and Restricting Orifice

Requirement: An orifice on the PCW makeup water line shall be sized to limit flows to the surge tanks to a value that the overflow line can support and designed in accordance with ASME B31.3, *Process Piping.* [Sections 4.4.26.3, 4.4.26.4, PDSA–LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12305]]

Basis Discussion: The surge tank is only vented to the atmosphere—not open to the atmosphere—so there is a chance that a pressure head could build up in the tank if it is overfilled to the point of water rising into the vent. The tank's overflow line prevents the water from being overfilled, provided the line is sized to accommodate the rate of water entering the tank. The orifice limits water flow into the surge tank to the rate that the overflow line can handle. The allowable flow rate of the makeup water is dependent on the size of the surge tank's overflow line, so the overflow line and the orifice designs depend on each other.

The requirement in Section 3.15.4.7of this SDD calls for all piping and valves in the system to ASME B31.3. The requirement is specifically stated here because it is a specific safety requirement.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Review the design to verify the orifice is sized to the flow rate the overflow line can accommodate.	Document in a DVR.
I	ENG	Review the design to verify the orifice and overflow piping are designed in according to ASME B31.3.	Document in an EQP.

3.8.2.7 Overflow Line Support

Requirement: The overflow line for each cooling water circuit shall be supported independently of the surge tank. [Sections 4.4.26.3, 4.4.26.5, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12306], [ID : WTP-PSAR-ESH-01-002-03 ID#12315]]

Basis Discussion: The overflow line has its own support structure and is not dependent on its associated surge tank for source in a seismic event. While the surge tank is SC-III due to adverse interaction potential, the surge tank is not classified as SS because it does not play an important role in the overflow line's safety function.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the overflow line does not depend on the associated surge tank for seismic support.	Document in a DVR.

3.8.3 System Interface Requirements

None.

3.8.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.9 Melter Enclosure

3.9.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.9.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.9.2.1 Anchored Enclosure

Requirement: The melter enclosure shall be anchored to prevent motion during a SC-III event. [Sections 4.4.2.3, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]]

Basis Discussion: Structural support for the melter shell is provided through the melter enclosure. The melter shell needs to remain intact to provide a confinement boundary to direct offgas to the offgas system. This may be accomplished via anchoring the enclosure to the melter rails with anchor pins.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the design of the anchorage of the melter enclosure to verify it provides structural support so that the melter shell remains intact during a SC-III event.	Document in DVR.
I	ENG	Review the design for conformance to the analysis.	Document in DVR.
I	SU/ COM	Verify the melter enclosure has been anchored per the design documents.	Document in an evaluation and assessment report.

3.9.2.2 Live and Drop Load Requirements for the Shield lid

Requirement: [HOLD] The top of the enclosure, the shield lid, shall withstand distributed loads in accordance with ASCE7-98, *Minimum Design Loads for Buildings and Other Structures*; dropped loads lifted 3 ft in height and 3500 lb in weight, a point load of 5000 lb. The dropped loads shall be treated as live loads. The melter enclosure shall retain confinement and operational integrity for this and lesser-dropped loads. [Section 4.4.2.5, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11770], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] [Section 15.3.4, BOD, [ID : DB-ENG-01-001 ID#12710]]

Basis Discussion: Loads are routinely lifted over the melter for maintenance procedures such as change out of the bubblers, air lances, feed nozzles and level detectors and initial insertion of the startup heaters and 300-lb batches of frit.

This requirement is on HOLD pending a revision of the BOD requirement per a communication from the Requirements Developer. The design should be identified as incomplete on any DCL, pending completion of this referenced ATS. (ATS-MGT-15-0121)

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the shield lid for a 3500 lb live load dropped from 3 ft and a point load of 5000 lb.	Document in a DVR.
I	ENG	Review the design to verify it conforms to the analysis.	Document in a DVR.

3.9.3 System Interface Requirements

System interfaces with the GRE are listed in Section 3.15.3.4.

3.9.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.9.4.1 Allowing Access to SSCs While Preserving Enclosure Containment

Requirement: The system shall allow maintenance operations to be accomplished without compromising the melter enclosure containment. [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12714]]

Basis Discussion: Access panels on the shield lid and access doors on the side of the melter enclosure allow workers to install and remove equipment without compromising the melter containment. Maintenance activities will take place when there is no need for containment, when the cold cap has burnt off. Doors and panels are to be replaced/shut so that containment of offgas will not be compromised when normal melter operations resume.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify maintenance operations can be accomplished without compromising the melter enclosure containment.	Document in a joint assessment with operations.
D	SU/ COM	Demonstrate the bubblers, thermal couples, level detectors, air lifts, startup heaters, jackbolts, and other components inside the melter enclosure can be accessed without compromising melter containment.	This demonstration will be performed after the melt pool has been stable at 1150 °C (2100 °F) for a time to verify thermal expansion of the melter will not compromise maintenance operations.

3.9.4.2 Shield Lid Structure

Requirement: The shield lid shall be designed with structural bracing and guide tubes for SSCs penetrating the melter lid. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12704]]

Basis Discussion: Guide tubes aide in the placement and removal of consumables and the temporary startup heaters. Structural bracing support these SSCs.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the shield lid has structural bracing and tube guides for penetrating SSCs.	Document in an evaluation and assessment.

3.9.4.3 Design for Decontamination of the Melter Enclosure

Requirement: The exterior surface of the melter enclosure shall have a nonpermeable surface finish that will facilitate decontamination. [Section 5.2, ORD, [ID : RPT-OP-01-001 ID#1047]]

Basis Discussion:. The exterior of the melter enclosure will be the only part of the actual melter that will be decontaminated. At the end of a melter's life, the melter will be removed and buried as one package all contained within the melter enclosure.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the exterior surface of the melter enclosure is a nonpermeable surface that will facilitate decontamination.	Review with Radiological Engineering.

3.10 Refractory

3.10.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.10.1.1 Refractory Expansion Control

Requirement: The design shall include a refractory control system using jackbolts to actively control melter refractory expansion. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12702]]

Basis Discussion: Thermal cycling takes place throughout the refractory; however, it is most pronounced in the plenum refractory where the temperature can vary from 400 °C to 1100 °C (752 °F to 2012 °F) based on the feed rate and feed chemistry.

As mentioned in the basis discussion in Section 3.6.2.1, refractory is stabilized by jackbolts on three sides of the melter and the fixed melter shell on the discharge chamber side.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the jackbolts are in used in the refractory control system.	

3.10.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirement

3.10.2.1 Melt Pool, Plenum, and Discharge Chamber Refractory

Requirement: The refractory for the main section of the melter shall be provided in two sections: melt pool and plenum. Each discharge chamber will be enclosed in refractory. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12702]]

Basis Discussion: The main design concern for the melt pool refractory is to contain the bulk glass, as discussed in Section 3.5.2.2 of this SDD. The main design concerns for the plenum refractory are for the refractory to withstand the corrosive offgas from the cold cap and thermal cycling.

See Section 3.4.1.6 for corrosion requirements for the plenum refractory.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify refractory used in different portions of the melter meet the containment requirements given in Section 3.5.2.2 of this SDD, and the corrosive and thermal environment requirments in Sections 3.4.1.6 and 3.4.1.7 of this SDD..	

3.10.3 System Interface Requirements

None.

3.10.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.11 Cooling Panels

3.11.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.11.1.1 LMP System – Melter Cooling Panels

Requirement: The LMP melter cooling panels shall interface with the LAW PCW to supply cooling panels and receive return water from the melter cooling panels. This functional requirement shall continue to operate during a loss of site power to prevent boiling in the cooling panels. (D.1)

Basis Discussion: The LMP melters use cooling panels to remove heat from the glass contact refractory. System interface occurs at the manual isolation valves located on each supply pipeline and in piping downstream of the manual isolation valve on the return pipeline. See 24590-WTP-3YD-PCW-00001, *WTP Plant Cooling Water System Design Description*, for additional information regarding the PCW system.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform analysis of system to determine the required cooling water flow rate to be delivered to the LMP melter cooling panels to meet cooling demand.	Document in an evaluation/assessment.
I	ENG	Review of design for conformance to the analysis results.	Document in an evaluation/assessment.
I	ENG	Review design to verify PCW will continue to provide cooling water to the cooling panels during a loss of site power.	Document in an evaluation/assessment.

3.11.1.2 Refractory Cooling

Requirement: The design shall include refractory cooling. [Section 15.1, BOD, [ID : DB-ENG-01-001 ID#12682]] (E.1), (E.3)

Basis Discussion: Although the cooling panels are an integral part of the bulk glass and offgas containment systems, there are actually very few explicit upper tier requirements for them.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the design contains sufficient cooling to satisfy the confinement and containment requirements for bulk glass and offgas as stated in Sections 3.5.2.1 and 3.5.2.2 of this SDD.	

3.11.1.3 Melter Enclosure Cooling

Requirement: The LAW melter cooling loops shall maintain enclosure surface temperatures for personnel safety access in addition to the refractory cooling. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12704]] (E.3)

Basis Discussion: As an LSM, the LAW melter is intended to allow personnel access to its sides and surface. The preliminary design of the melter required a maximum surface temperature of 95 °F (35 °C) (Section 6.1.2.1, 24590-QL-HC4-W000-00094-03-00001, Rev 00A, *REPORT - LAW Melter Design Basis Report*).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the cooling water system can maintain the external temperature of the melter enclosure in locations that are accessible to workers to a maximum to allow safe personal access while providing the necessary cooling for bulk glass containment.	See OSHA limits
I	ENG	Review the design to verify there is a method for monitoring the temperature workers will experience next to the outside of the melter enclosure.	This would apply to the top of the shield lid as well as the melter gallery in general.

3.11.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

Requirement: The design of the melter must prevent the accumulation of water between the cooling panels and the melter refractory. There shall be no sealed cavities between the cooling panels and the melter refractory. [Sections 4.4.2.3, 5.6.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#11759], [ID : WTP-PSAR-ESH-01-002-03 ID#13056]] (F.1)

Basis Discussion: The system needs to be designed so that in the event of a cooling panel rupture, the cooling water drains toward the melter drains and away from the refractory and melt pool to prevent damage to the melter.

Requirements for drains on the melter are given in Section 3.15.4.22 of this SDD.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify that no sealed cavities exist between the cooling panels and the melter refractory so the cooling water from all cooling panels can drain freely away from the refractory in the event of a cooling panel rupture.	Document in DVR.

3.11.3 System Interface Requirements

The cooling water is supplied by the PCW system. In the event of a cooling water rupture, the cooling water drains to the RLD.

3.11.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.11.4.1 Operations Driven Cooling Loop Requirements

Requirement: The design of piping delivering water to the cooling panels shall include the following features:

- The capability to purge the contents of the system and decontaminate, flush, and drain/gas purge the piping and equipment.
- The capability to sample the cooling water in the circuit.
- Backup or redundant cooling water systems so minimum plant operations (idle melters) can be supported during maintenance activities that necessitate the complete isolation or drainage of part of the cooling tower system.
- Instrumentation to monitor process leaks to prevent radioactive discharge into streams that are not radioactive.

[Section 14.7, ORD, [WTP-RPT-OP-01-001 ID#1505], [WTP-RPT-OP-01-001 ID#1501], [WTP-RPT-OP-01-001 ID#1502], [WTP-RPT-OP-01-001 ID#1504]]

Basis Requirement: These are standard operations driven design requirements for cooling loops.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes the features listed in the requirement.	

3.12 Discharge Chambers

3.12.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.12.1.1 Discharge Chamber Heating Requirements

Requirement: Whenever normal plant power is available, discharge chambers shall be continuously heated by lid mounted heaters. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12720]] (A.8)

Basis Requirement: Constant heating maintains the discharge chambers above 800 °C (1472 °F). 24590-WTP-PL-RT-03-001, *ILAW Product Compliance Plan*, calls for the molten glass will be poured into the container at 800 °C or higher; to prevent the introduction of materials that could form liquids at ambient conditions.

The current design includes a backup bus/ motor control center (MCC) for the discharge heaters to maintain normal power. There is no back up for the loss of normal power for the discharge chamber heaters or the electrodes. If normal power is lost, glass-making operations will have to cease so there will be no need for heated discharge chambers.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design allows for continuous of the discharge heaters under normal plant operating conditions..	

3.12.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.12.2.1 Discharge Chamber Capacity

Requirement: Each LAW melter shall have two identical and independently operated discharge chambers capable of supporting the required melter design capacity of 15 MTG/day individually. [Sections 15.3.1, 15.3.2 BOD, [ID : DB-ENG-01-001 ID#12692], [ID : DB-ENG-01-001 ID#12697]] (A.9)

Basis Discussion: After passing through the discharge chamber, the glass is poured into the ILAW containers. The LPH system locates an ILAW container under a discharge chamber in the pour cave by a turntable. Each discharge chamber in the LMP has one turntable dedicated to it. Requiring each discharge chamber to have the capacity to support the entire melter production provides continuous glass production from the LMP in the event that one turntable on the LPH system is out of service.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Verify the design of a single discharge chamber allows for an output of 15 MTG/day.	Reports exist from pilot tests for this verification.

3.12.3 System Interface Requirements

System interfaces with the GRE are listed in Sections 3.15.3.6 and 3.15.3.7.

3.12.3.1 Power Supplies for Startup Heaters and Discharge Chamber Heaters

Requirement: Power supplies for discharge chamber heaters and startup heaters shall provide power at the power level required by the heater. [Section 8.3.6.1, BOD, [ID : DB-ENG-01-001 ID#10735]]

Basis Discussion: Power for the single-phase startup and discharge chamber heaters are supplied by the 480-V LVE system. The LVE power supplies LVE-PSUP-20001, LVE-PSUP-20002 and LVE-PSUP-20101 are part of LMP. The power supplies convert a 3-phase 480-V input from a 480-V feeder to a single-phase variable voltage output at the power level required by the heater.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Review the design to verify power supplies match the requirements for the startup heaters and discharge chamber heaters.	Documented in an evaluation/assessment.

3.12.4 Other Technical, Specialty, Operations and Maintenance Requirements

None.

3.13 Electrodes

3.13.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.13.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.13.2.1 Provide Joule Heating

Requirement: Electrodes mounted on the refractory walls of the melter shall provide joule heating for the transformation of slurry mix into homogeneous glass melt. [Sections 15.3.1, 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12690], [ID : DB-ENG-01-001 ID#12720]], [Section C.7(d)(3)(ii), DOE Contract DE-AC27-01RV14136 (DOE 2000), [ID : DE-AC27-01RV14136 Section C ID#1202]] (A.2), (H.1.1.k)

Basis Discussion: The method of joule heating has been chosen as the vitrification method for WTP.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify that the number and size of electrodes can provide sufficient current in the melt pool to meet the production rate in Section 3.4.1.1.	
I	ENG	Verify the design includes the number and size of electrodes determined by the analysis.	

3.13.3 System Interface Requirements

None.

3.13.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.13.4.1 Power Supplies for Electrode and Extension Bus Requirements

Requirement: Electrodes and extension buses shall be capable of carrying the current at the voltage required for all modes of melter operation after startup. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12721]] (G.1)

Basis Discussion: The design calls for the electrodes to be embedded in the refractory, so there is no way to change electrodes for different melter operation modes.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the electrode and extension buses are sized for all melter operation modes after startup.	
I	ENG	Review the design to verify it conforms with the analysis.	

3.13.4.2 Power Supplies for Electrodes - Magnetic Coupling

Requirement: Extension buses and bus jumpers shall minimize harmful magnetic coupling with materials they pass through. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12721]]

Basis Discussion: The high current transmitting through the electrode's bus bars generates relevant magnetic fields.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I	ENG	Analyze the design to determine the level of magnetic coupling experienced by SSCs close to extension busses and jumpers.	
A	ENG	Analyze the design to determine locations where magnetic coupling and other electromagnetic interference effects could be harmful to other components and what shielding could be used to mitigate these effects.	
I	ENG	Review the design to verify magnetic coupling will not harm any SSCs.	

3.13.4.3 Power Supplies for Electrodes - Expansion and Contraction of Connections and Busses

Requirement: Connections to extension buses shall account for expansion and contraction. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12721]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify the connections for bus extensions can expand and contract to operate within the temperature profile of their environment.	

3.13.4.4 Power Supplies for Electrodes - Unit Size and Feed

Requirement: Power for each melter's electrodes shall be provided by a static power supply (SPS) composed of two 50 % units, fed by a 13.8-kV power feed from load group A and load group B switchgear. [Section 8.3.3, BOD, [ID : DB-ENG-01-001 ID#10721]] [Section 16.1, ORD, [ID : RPT-OP-01-001 ID#1612], [ID : RPT-OP-01-001 ID#1609]] (G.1)

Basis Discussion: Power for the electrodes is provided by the MVE system. The power supplies are part of LMP. Using two 50 % units in one power supply allows the melter to be maintained in an idle mode if one unit is lost. The SPS designation requires the power supplies to be a type of power electronic converter, not a standalone diesel or gas generator.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis to verify the power supplies are sized so two 50 % units accommodate all modes of melter operation after startup.	Documented in an evaluation/assessment.

3.14 Monitoring and Controls

3.14.1 Mission and Functional / Performance Requirements (Including States/Modes)

3.14.1.1 Monitoring Average Temperature in the Melt Pool

Requirement: The design shall contain instrumentation to monitor the average melt pool temperature. (A.2), (H.1.1.a)

Basis Discussion: A means of temperature monitoring is needed to assure the requirement in Section 3.4.1.3, Operating Temperature, is met. The average temperature is computed in the PCJ system.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the temperature will be monitored across a representative area of the melt pool.	
I	ENG	Review the design to verify the PCJ system will compute the average temperature based on working measurement instruments.	The reliability of the temperature measurement devices in the melt pool can vary depending on glass build up on the instruments.

3.14.1.2 Monitoring and Control of Electrode Power Supply

Requirement: The design shall include the capability to monitor and control the electrodes' power supplies. (A.2), (H.1.1.k)

Basis Discussion: Controlling the power to the electrodes is an integral function in controlling the joule heating and the melt pool temperature. Vendor data on monitoring and controlling the electrode power supply are given in: 24590-RMCD-02569, *E-Media - O&M Manual - Law Power Supply*.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the electrode power supply design to verify it contains the necessary monitoring and controls.	
T	SU/ COM	Perform an integrated test to demonstrate the ability to monitor and control the output from the power supplies.	

3.14.1.3 Startup Heater Ramp Rate

Requirement: The LMP melter startup heater controls shall be designed with an automatically controlled initial startup heating ramp rate during the refractory bake-out period. (H.1.1.l)

Basis Discussion: A specific heat up schedule for the LMP melters will be developed based on vendor data, engineering judgment, along with any operational data, trends, and observances.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design to verify the melter startup heaters and controls are designed with a controlled initial startup heating ramp rate during the bake-out period.	

3.14.1.4 Process Control System - Instruments

Requirement: Instruments connected to the PCJ system shall not perform any credited active safety function. Instruments connected to the PCJ may include and perform safety boundary or retention functions. LMP instruments shall use standard commercially available instrumentation and communication protocols to interconnect to the PCJ system. Fieldbus or Modbus communication may be used. [Section 9.4.1, BOD, [ID : DB-ENG-01-001 ID#10963] [ID : DB-ENG-01-001 ID#10964]]

Basis Discussion: The PCJ is used as the normal process control system. The PCJ allows remote operator control and monitoring of the LMP processes (e.g., provisions for level, temperature, pressure, and cooling along with the ability to control and monitor pumps and valves to operate the LMP system). Alarms and warnings are provided to bring operator attention to and allow rectification of abnormal process situations.

The instruments are part of the LMP. The system logic and control software is part of the LMP, but resides and is implemented by the PCJ. The software interfaces with software and hardware on other systems to collectively form an integrated control system for the WTP Project. Software requirements originate from 24590-WTP-QAM-QA-06-001, *Quality Assurance Manual* (QAM), and the procedure for software life cycle management (24590-WTP-GPP-SQP-208, *Plant Software Life Cycle Management*).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify required specifications (related to PCJ interface) are included in material requisitions (MR), used to procure instruments.	Perform a design review, including applicable procurement documentation, to verify system instruments that interconnect to the PCJ are standard commercially available. Documented in an evaluation and assessment.

3.14.1.5 Glass Pour Stream Monitoring

Requirement: The LMP system shall be designed with cameras to monitor the glass pour stream. [Section 12.4, ORD, [ID : RPT-OP-01-001 ID#1390]] [Section 9.3, BOD, [ID : DB-ENG-01-001 ID#10957]] (H.3.1)

Basis Discussion: The BOD has a general requirement to use cameras for viewing operations in high radiation areas or caves. The closed circuit television (video) (CCTV) cameras are part of the process and mechanical handling CCTV system (PTJ), but are cooled by ISA air carried on LMP designated piping.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify it includes cameras for viewing the pour stream.	

3.14.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.14.2.1 Safety Significant Interlocks

3.14.2.1.1 Melter Plenum High Pressure (Reduced Vacuum)

Requirement: Upon detection of high pressure (reduced vacuum) (**set point TBD**) in the melter plenum, the PPJ shall:

1. Terminate melter feed on the affected melter by simultaneously isolating air and water supplies to the LFP melter feed ADS pumps.
2. Stop injection of air to the LVP film coolers.
3. Stop injection of process air to the LVP WESP.
4. Stop demineralized water flow to the LVP melter film cooler.
5. Actuate open isolation valves on the LOP standby offgas line.

[Sections 4.4.8.1, 4.4.8.3, Appendix 4A PDSA – LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#11946], [ID : WTP-PSAR-ESH-01-002-03 ID#11950]] (H.2.1) (H.2.1.1), (H.2.1.2), (H.2.1.3), (H.2.1.4)

Basis Discussion: A high plenum pressure indicates a loss of vacuum in the plenum, which could lead to a loss of offgas confinement. This confinement is important only when a cold cap exists. Offgas is created while a cold cap reacts with the melt pool. After the cold cap has dissolved into the melt pool, there is no potential for an offgas release. The plenum pressure is not an absolute pressure; it is the pressure difference relative to the annulus.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the system to determine the set point for the pressure differential between the plenum and the annulus that will trigger a high pressure reading in the PPJ system.	
I	ENG	Review the design for incorporation of the interlock.	Documented in DVR.

T	SU/ COM	Perform a test to verify the PPJ does the following upon detection of high pressure (reduced vacuum) (**set point TBD**) in the melter plenum: • Terminates melter feed to the affected melter by simultaneously isolating air and water supplies to the LFP melter feed ADS pumps. • Stops air injection to the LVP film coolers • Stops process air to the LVP WESP • Stops demineralized water to the LVP film coolers • Opens isolation valves on the LOP standby offgas line	The PPJ, LMP, LFP, LVP, and LOP systems are required to be operational to perform this test.

3.14.2.1.2 Terminate Melter Feed - Melter Lid Cavity Cooling Water High Temperature

Requirement: The PPJ shall interface with the LMP and LFP systems to terminate feed to both melters upon detection of high cooling water temperature **(set point TBD)** in the melter lid cavity. The method of feed termination is achieved by first isolating:

1. First isolating air to the melter feed ADS pumps.
2. Followed by the isolation of water (after line flushes, as necessary) to the melter feed ADS pumps.

[Sections 4.4.27.1, 4.4.27.3, PDSA - LAW Facility, [ID : WTP-PSAR-ESH-01-002-03 ID#12321], [ID : WTP-PSAR-ESH-01-002-03 ID#12325]] (E.4), (H.2.2), (H.2.2.1)

Basis Discussion: Section 4.4.27.5 of 24590-WTP-PSAR-ESH-01-002-03, *Preliminary Documented Safety Analysis to Support Construction Authorization; LAW Facility* states the following:
"Feed is terminated to both melters, so that both melter cold caps are gone in the event that continuing temperature rises cause plate failure. This will ensure that there is no danger from an upset in one melter (e.g., excessive flow area into the melter beyond the capability of the exhausters to maintain depression) affecting the other melter in a way that could result in a release of offgas (e.g., losing depression due to preferential flow from the failed melter).

Terminating the air to the melter feed ADS pumps terminates melter feed. However, allowing unlimited water additions to the melter once the primary melter feed has been stopped can extend cold cap durations. Therefore, water to the ADS pumps is also isolated. A timed delay in water isolation is allowed for flushing activities, with related analytical limits and setpoints accounting for this time delay. Based on the results presented in 24590-LAW-RPT-ENS-10-001, allowing a short delay in water isolation (on the order of 5-10 min) does not change that the NOx concentrations 2 hr after feed termination will be well below temporary emergency exposure limits (TEEL)-3 values."

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design for incorporation of the interlock.	Documented in DVR.
T	SU/ COM	Perform a test to verify the capability to terminate transfer from MFVs to the melters, using the PPJ, when high temperature **(set point TBD)** is reached in the melter lid cooling cavity:	The PPJ, LMP, and LFP systems are required to be operational to perform this test.

3.14.2.2 Implementation of Active Safety Instrumented Functions

Requirement: The active safety instrumented functions for the LMP system shall be designed in accordance with the safety criterion 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of 24590-WTP-SRD-ESH-01-001-02, *Safety Requirements Document Volume II.* [Safety Criterion, 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2, SRD, [ID : SRD-ESH-01-001-02 ID#44], [ID : SRD-ESH-01-001-02 ID#46], [ID : SRD-ESH-01-001-02 ID#47], [ID : SRD-ESH-01-001-02 ID#50], [ID : SRD-ESH-01-001-02 ID#53], [ID : SRD-ESH-01-001-02 ID#54]] (H.2)

Basis Discussion: The SRD establishes the criterion and applicable standards for the safety design. The design processes including 24590-WTP-GPG-J-015, *Safety Instrumented System Implementation* and electrical design criteria are used to ensure independence and that the design complies with the mandated standards. The completed designs are documented in Safety Systems Requirements Specification and other design documents, which are required to be verified to ensure compliance with the standards.

Verification: Verification is expected to be achieved through:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the Safety Systems Requirements Specifications and designs are in accordance with the criterion and standards in safety criterion 4.3-1, 4.3-3, 4.3-4, 4.3-6, 4.4-1 and 4.4-2 of 24590-WTP-SRD-ESH-01-001-02, Safety Requirements Document Volume II.	DVR report

3.14.2.3 Active Safety Instrumentation, Programmable Protection System

Requirement: The LMP Instruments with active safety functions are required to interface with the PPJ or be engineered as local safety instrumented functions. Signal interfaces shall use standard 4 20 mA or digital contacts. [Section 7.1, BOD, [ID : DB-ENG-01-001 ID#10529]] (H.2)

Basis: Active safety instrumentation is implemented independently to the normal control system (PCJ/ MHJ) through the PPJ system or in local logic solvers. The PPJ is the main safety system logic solver used on WTP and includes logic programming to implement the active safety controls. Appendix C provides a list of the LMP active safety instrumented functions and implementing components for the LMP system.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify required interface included in specifications and MRs used to procure active safety instruments.	

3.14.2.4 Dangerous Waste and Air Permit Required Monitoring and Controls

3.14.2.4.1 Redundant Monitoring for Melter Plenum Pressure

Requirement: The LMP system shall include redundant pressure measurement in the plenum, including nonsafety differential pressure transducer (PDTs) and differential pressure indicator (PDIs) to monitor the pressure difference between the plenum and the annulus. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12703]] (A.6), (A.6.1), (H.1.1.b)

Basis Discussion: Maintaining a negative pressure in the plenum with respect to the annular space is critical for offgas confinement. The BOD requires the redundant pressure measurement in the plenum. Table III.10.H.C, DWP specifies two nonsafety PDIs and two nonsafety PDTs: LMP- PDT-1410, PDI-1410 and LMP-PDT-1411 / PDI-1411 for melter 1; and LMP-PDT-2410 / PDI-2410 and LMP- PDT-2411 / PDI-2411 for melter 2; however, only one set of instruments is required to be in operation in each melter during the melter feed operation. There are also SS PDIs/PDTs interlocked with the PPJ system. More discussion on these interlocks is given in Section 3.14.2.1.1 of this SDD.

Section 3.3.B.2 of 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters,* calls for the plenum pressure to be 5 inWC below the annulus pressure (at a 5 in. vacuum relative to the annulus). There is no specific requirement for a nonsafety, PCJ, interlock to maintain this pressure difference; however, there is a PCJ interlock in the current design. The nonsafety plenum pressure interlock works through the PCJ system to stop melter feed and make corrections in the LVP and LOP system to restore proper plenum vacuum before the PPJ system would have to be engaged. This interlock is referred to in [ID : WTP-PSAR-ESH-01-002-03 ID#11961], which states the PPJ interlock will execute "when the PCJ has failed to take sufficient corrective actions to keep the melter plenum pressure in a normal operating range."

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes redundant plenum pressure indicators, including signals from either LMP-PDT-1410 / PDI-1410 and LMP-PDT-1411 / PDI-1411 for melter 1; and LMP-PDT-2410 / PDI-2410 and LMP-PDT-2411 / PDI-2411 for melter 2 as specified by Table III.10.H.C, DWP.	No specific pressure set points are required for this verification. Document in a DVR.

3.14.2.4.2 Plenum Temperature

Requirement: The LMP design shall include instrumentation for monitoring of the plenum temperature. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]], (A.5), (H.1.1.c)

Basis Discussion: The verification table below provides instruments specified by the DWP. Melter feed and cold cap chemistry directly affect the plenum temperature. Monitoring of the plenum temperature will be used in determining the feed rate as the plenum temperature is an indication of the state of the cold cap.

The current design links these temperature elements with a nonsafety interlock through the PCJ system to shut down melter feed from the LFP system due to low plenum temperature, but there is no direct requirement for this interlock.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes instrumentation specified by the DWP to monitor plenum temperatures.	Document in a DVR **CTNs** specified by Table III.10.H.C, DWP Melter 1 LMP-TE-1267C, 1272C, 1280C LMP-TT-1267B LMP-TI-1267C, 1272C, 1280C Melter 2 LMP-TE-2267C, 2272C, 2280C LMP-TT-2267B LMP-TI-2267C, 2272C, 2280C

3.14.2.4.3 Melter Lid Cooling Cavity Temperature

Requirement: The LMP design shall include instrumentation for monitoring the melter lid cooling cavity temperature. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] (E.4), (H.1.1.d)

Basis Discussion: A high temperature in the melter lid cooling cavity could lead to a deformation of the gas barrier lid plate that could in turn compromise the offgas containment system. The DWP specifies nonsafety temperature elements, temperature transmitters, and temperature indicators as listed in the verification table below. A safety high temperature interlock for the melter lid cooling cavity temperature is described in Table 2-1 and Section 3.14.2.1.2 in this SDD.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the design includes the temperature instrumentation specified by the DWP.	Document in a DVR. **CTNs** specified by Table III.10.H.C, DWP Melter 1 LMP-TE-1640, LMP-TT-1293, LMP-TI-1640 Melter 2 LMP-TE-2640, LMP-TT-2293, LMP-TI-2640

3.14.2.4.4 Melt Pool Level and Density Monitoring

Requirement: The design shall include instrumentation for monitoring of the melt pool level and density. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] (A.4), (B.1), (H.1.1.e)

Basis Discussion: Operators read level indicators to monitor the melt pool level to determine when to transfer glass to the discharge chamber. Abnormal drops in the melt pool level could indicate a leak of bulk glass.

Melt pool density is derived in the PCJ by dividing the difference in back pressures at two known heights by the known height difference. Melt pool level is derived by dividing the back pressure at the location by the melt pool density. Algorithms for measuring density and level from the back pressure on level and density probes are described on drawings 24590-LAW-M6-LMP-00002002, 24590-LAW-J3-LMP-01013, 24590-LAW-M6-LMP-00032002, and 24590-LAW-J3-LMP-01015.

Instruments specified by the DWP for melt pool monitoring are listed in the following verification table.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes the level and density instrumentation specified by the DWP.	Document in a DVR. CTNs specified by Table III.10.H.C, DWP Melter 1 LMP-DT-1404 LMP-DI-1404 LMP-LT-1405 LMP-LI-1405 Melter 2 LMP-DT-2404 LMP-DI-2404 LMP-LT-2405 LMP-LI-2405

3.14.2.4.5 Refractory Temperature Monitoring and Recording

Requirement: The LMP design shall include instrumentation to monitor and record the temperature of the melt pool refractory so that refractory thermocouple temperature data can be maintained for inspection. [Section III.10.K.1.f.vi, DWP, [WA7890008967 WTP ID#2472]] (H.1.1.f)

Basis Discussion: An increase in the refractory temperature could be an indication of bulk glass leaking from the refractory.

The DWP requires that a record of refractory thermocouple data be maintained for inspection by the Washington State Department of Ecology.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes instrumentation to maintain refractory thermocouple temperature data for inspection.	

3.14.2.4.6 Cooling Water Flow and Temperature Monitoring and Recording

Requirement: The LMP design shall include instrumentation to monitor and record the cooling water flow and temperature in the cooling panels surrounding the melt pool. [Sections III.10.I.1.e.v, III.10.I.1.f.v, III.10.I.1.f.vi, DWP, [WA7890008967 WTP ID#2174], [WA7890008967 WTP ID#2175], [WA7890008967 WTP ID#2176]] (E.1), (H.1.1.g)

Basis Discussion: A loss of cooling water could result in loss of bulk glass containment. Instruments specified by the DWP are listed in the following verification table.

The DWP requires that a record of cooling water temperature and flow data be maintained for inspection by the Washington State Department of Ecology.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify that the cooling water flow rate and temperature can be monitored and recorded.	CTNs referenced in section III.10.I.1.f.v of the DWP Melter 1 LMP-FT/TI&FI-1206, FT/TI&FI-1209, FT/TI&FI-1215, FT/TI&FI-1218, FT/TI&FI-1221, FT/TI&FI-1224, FT/TI&FI-1227, FT/TI&FI-1233, FT/TI&FI-1236, FT/TI&FI-1536, FT/TI&FI-1539 Melter 2: LMP-FT/TI&FI-2206, FT/TI&FI-2209, FT/TI&FI-2215, FT/TI&FI-2218, FT/TI&FI-2221, FT/TI&FI-2224, FT/TI&FI-2227, FT/TI&FI-2233, FT/TI&FI-2236, FT/TI&FI-2536, FT/TI&FI-2539

3.14.2.4.7 Feed Encasement Assembly Leak Detection

Requirement: The LMP design shall include cable type conductivity element to detect leaks of slurry feed in the melter feed nozzle encasement assemblies. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] (H.1.1.h)

Basis Discussion: The melter feed nozzle encasement assemblies are part of the LMP.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes cable type conductivity elements to detect leaks in the feed nozzle encasement assemblies.	Document in a DVR. CTNs specified by Table III.10.H.C, DWP Melter 1 LMP-LE-1632 LMP-LAH-1632, LMP-LDB-00001 Melter 2 LMP-LE-2632 LMP-LAH-2632, LMP-LDB-00002

3.14.2.4.8 Air Lift Risers

Requirement: The LMP design shall include controls for the air lift lance associated with each discharge chamber. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] (A.7), (B.1), (H.1.1.i)

Basis Discussion: The air lift lances assists in raising batches of molten glass from the melt pool into the discharge chambers. Valves and controls specified by the DWP are listed in the verification table below. The air lift lances are purged with argon from the miscellaneous gases system (MXG).

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify it contains controls for the air lift lance specified in the DWP.	Document in a DVR.
D	COM	Demonstrate control of the movement of glass from the melt pool to the discharge chamber.	CTNs specified by Table III.10.H.C, DWP Melter 1 LMP-YV-1047 LMP-YC-1047 LMP-YV-1125 LMP-YC-1125 Melter 2 LMP-YV-2047 LMP-YC-2047 LMP-YV-2125 LMP-YC-2125

3.14.2.4.9 Container Fill Level Detection

Requirement: The LMP design shall include an infrared (IR) camera to monitor the container's level. [Table III.10.H.C, DWP, [ID : WA7890008967 WTP ID#589]] [ILAW Product Compliance Plan, Section 4.1.5.1, [ID : WTP-PL-RT-03-001 ID#10340]] (H.1.1.j), (H.3.2)

Basis Discussion: Operators need to determine the level of the glass in the container so the container is not overfilled. The level element for this task required by the DWP is an IR camera with a level indicator that will send a numeric signal to the control room indicating the container level. The current design also provides for transmitting the IR image of the molten glass in the container as a way for operators to view the container level.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify it contains instrumentation for glass pour operators to monitor the container fill level.	Document in a DVR.

Verif. Method	Verif. By	Plan	Notes/Comments
D	SU/ COM	Demonstrate the container level can be determined from the facility control room.	CTNs specified by Table III.10.H.C, DWP Melter 1 LMP-LE-1466 LMP-LT-1466 LMP-LI-1466B LMP-LE-1511 LMP-LT-1511 LMP-LI-1511B Melter 2 LMP-LE-2511 LMP-LT-2511 LMP-LI-2511B LMP-LE-2466 LMP-LT-2466 LMP-LI-2466B

3.14.3 System Interface Requirements

3.14.3.1 Container Cooling for Infrared Image Improvement

Requirement: The portion of the ILAW container that is inspected by the IR camera shall be air cooled with air from the PSA, carried through LMP designated piping. (C.2)

Basis Discussion: As glass is poured into the container, the outside of the container will also heat up, thus creating its own IR signature. Cooling the outside of the containers provides a sharper IR image of the glass inside the container. This same cooling air will also be used to cool the outside of the IR camera to improve its reliability and lifespan.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A/I/T	ENG SU/ COM	Verify air cooling is provided to the outside of the ILAW containers. Determine necessary temperatures and flow rates from pilot tests and tests during commissioning to determine the best flow rate and positioning for the air cooling nozzle.	See 24590-101-TSA-W000-0009-101-00007, Rev. A, *Report - RPP Pilot Melter Prototypic LAW Container and HLW Canister Glass Fill Test Results*, . Start with page 14, objective 2 –"IR Camera" with reference to document sections 4.2.2 and 4.2.4

3.14.3.2 CCTV Camera Location

Requirement: The LMP design shall include a camera for monitoring the glass pour stream and interface with the PTJ system. Closed circuit television video (CCTV) cameras shall be located to give optimum viewing angles and distance to suit the process. [Section 9.3, BOD, [ID : DB-ENG-01-001 ID#10957]] [Section 12.4, ORD, [ID : WTP-RPT-OP-01-001 ID#1390]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the CCTV cameras are located to give optimal viewing angles.	Documented in an evaluation and assessment.
D	SU/COM	Demonstrate the placement of the pour spout cameras can effectively be used to monitor glass pouring.	

3.14.3.3 CCTV Camera Cooling

Requirement: The LMP system design shall provide a means of cooling the exterior of the CCTV cameras operated by the PTJ system used for viewing the pour stream from the discharge chamber to the ILAW container. [Section 15.1, BOD, [ID : DB-ENG-01-001 ID#12682]] (C.1)

Basis Discussion: The high temperature area around the melter pour spout will challenge the operation of the CCTV cameras. Cooling the cameras will improve the cameras' lifespans. A vender report (24590-CM-POA-EEC0-00001-09-00001, *Analysis - Airflow Analysis for LAW Pour Head Viewing and Container Viewing Camera*) recommends an airflow rate of 6.1 scfm of cooling air at an original temperature of 15 °C (59 °F). The design calls for the cameras to be cooled with ISA air carried on LMP designated piping.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the design provides cooling air to the CCTV cameras.	

3.14.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.14.4.1 Transmitters Located on Racks

Requirement: The LMP system transmitters shall be located on racks in a C3 or less contaminated classified room to the extent practical. [Sections 9.1, 11.16, ORD, [ID : RPT-OP-01-001 ID#1186], [ID : RPT-OP-01-001 ID#1373]] [Section 9.5.6, BOD, [ID : DB-ENG-01-001 ID#11104], [ID : DB-ENG-01-001 ID#11106], [ID : DB-ENG-01-001 ID#11107]] [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12712]]

Basis Discussion: Locating transmitters on racks in C2/R2 areas as much as possible reduces exposure and use of personal protective equipment (PPE).

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design to verify LMP transmitters are located on racks in C3 areas or less contaminated rooms.	

3.14.4.2 Instruments Located Outside of C3 Contamination Areas

Requirement: The LMP system instruments, other than transducer panels housing liquid level systems and associated remote input/output (I/O), and pressure transducers that require maintenance shall be located outside the C3 contamination areas. [Sections 9.1, 11.6, ORD, [ID : RPT-OP-01-001 ID#1186], [ID : RPT-OP-01-001 ID#1373], [ID : RPT-OP-01-001 ID#1373]] [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12712]]

Basis Discussion: This location will minimize worker exposure during maintenance and protect instruments from adverse conditions.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the design calls for maintainable instruments to be located outside of a C3V area and give justification for those instruments that must be located in a C3V area.	

3.14.4.3 Flow Interruption

Requirement: The LMP flow meters shall be provided with bypass piping whenever flow interruption is not acceptable. [Sections 11.6, ORD, [ID : WTP-RPT-OP-01-001 ID#1373]]

Basis Discussion: This requirement enables the flow element to be isolated and repeated/replaced online with the system in service and continuing to provide cooling water to its users requiring uninterrupted flow.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analysis of LAW LMP to determine which lines require uninterrupted flow.	Document in an evaluation/assessment
I	ENG	Review design to ensure flow meters are provided with bypass piping for those line requiring uninterrupted flow.	Document in an evaluation/assessment

3.15 Other Structures, System, and Components Requirements

3.15.1 Mission and Functional / Performance Requirements (Including States/Modes)

None.

3.15.2 Nuclear Safety, ALARA, Environmental, and Other Regulatory Requirements

3.15.2.1 Penetrations through Fire Barriers

Requirements: Penetrations for the LMP system busses, piping, cables, and wires through fire barriers shall meet the requirements of DOE-STD-1066, *Fire Protection Design Criteria* and the International Building Code. [Section 4.4.17.4, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12119], [ID : WTP-PSAR-ESH-01-002-03 ID#12120], [ID : WTP-PSAR-ESH-01-002-03 ID#12121]]

Basis Discussion: ASTM E 119 is the code called out in 24590-LAW-FHA-RAFP-FP-0001, *Fire Hazards Analysis (FHA) for the Low-Activity Waste Facility (LAW)* for standard test methods for fire tests of building and construction materials.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify all components that penetrate a fire barrier are tested to not less than the required fire resistance rating of the barrier based on the fire exposure and acceptance criteria specified in ASTM E 119. Use of alternative methods for determining fire resistance shall be approved by the building official.	Document in a DVR or Document in an evaluation/assessment. Assessment to be submitted to the building official for approval.

3.15.2.2 Restriction of Cooling Water Supply for Melter Feed Nozzle Cooling

Requirement: The LMP system cooling water supply and return lines to the cooling jackets of the melter feed nozzles shall each contain a flow-limiting valve. These valves shall be manually adjustable, set to support normal operations as well as providing an upper limit to the flow in the event of a feed nozzle cooling jacket failure. [Sections 4.4.13, 4.4.13.2, Appendix 4A, PDSA-LAW, [ID : WTP-PSAR-ESH-01-002-03 ID#12040], [ID : WTP-PSAR-ESH-01-002-03 ID#12044]] (E.2)

Basis Discussion: The function of this valve is to limit the maximum allowable flow of water to the feed nozzle cooling jackets. Limiting the flow to the cooling jackets limits the amount of water that would go into the plenum in the event of a cooling jacket breach. Cooling water is kept out of the plenum to prevent a build up of steam that could pressurize the melter. These valves are manually adjustable, set to support normal operations as well as providing an upper limit to the flow in the event of a feed nozzle cooling jacket failure.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design has the correct valves.	Document in DVR.

3.15.3 System Interface Requirements

3.15.3.1 Bubblers

Requirement: The LMP system melter design shall include bubblers to inject compressed gas continuously into the molten melt pool to provide agitation to aid the mixing of the melting cold cap with the rest of the melt pool. [Section 15.3.3, BOD, [ID : DB-ENG-01-001 ID#12701]] (A.3)

Basis Discussion: The gas flow through the bubblers provide agitation in the melt pool and help to mix the melting cold cap in with the rest of the melt pool. The design currently calls for the ISA air to provide the gas flow for the bubblers.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the integration of the gas flow with the molten glass to verify bubblers will provide sufficient agitation to allow glass production to meet the requirement of Section 3.4.1.1 of this SDD.	
I	ENG	Review the design to verify the design contains required components for the bubblers.	

3.15.3.2 Preventing Cross Contamination – Plant Cooling Water

Requirement: The LMP system shall receive cooling water from the PCW via a primary/secondary closed recirculation system. [Sections 7.1, 14.7, ORD, [ID : RPT-OP-01-001 ID#1101], [WTP-RPT-OP-01-001 ID#1503]] (D.1)

Basis Discussion: Section 7.1, ORD calls for mitigation of and preventing cross contamination of process piping. The cooling water on the LMP side of the heat exchangers is considered possibly contaminated. Heat exchangers will separate the main PCW from cooling water used in the LMP.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the LMP design utilizes heat exchangers between the PCW and LMP cooling water to preclude cross contamination.	

3.15.3.3 Preventing Cross Contamination - Air Cooling

Requirement: ISA and PSA used for cooling SSCs shall discharge into the ventilation system of the room that houses the SSC being cooled or into another ventilation system with a higher order of contamination control. [Section 7.1, ORD, [ID : RPT-OP-01-001 ID#1101]] (C.1, C.2)

Basis Discussion: The instrument service air (ISA) and MXG used for instrumentation and bubbler in the melter plenum mixes with other gases in the plenum and discharge through the LOP system.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Verify the design allows instrument air and plant air used for cooling to be exhausted into an appropriate ventilation area.	

3.15.3.4 Grounding Metal Sections of the Melter

Requirement: Metal sections of the melter shell and discharge chamber lids, base, structure, and melter enclosure shall be electrically interconnected and connected to the facility grounding system, GRE, at four separate locations in accordance with Article 250 of NFPA 70-1999. [Section 15.3.7, 8.8.1.3, BOD, [ID : DB-ENG-01-001 ID#12724], [ID : DB-ENG-01-001 ID#10878]]

Basis Discussion: These sections that are grounded are electrically isolated from the melter electrodes and melt pool, and the discharge and startup heaters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify it includes grounding and electrical interconnections for the melter shell and discharge chamber lids, base, structure, and melter enclosure.	
A/I	ENG/ CON	Verify the metal parts of the melter have been electrically interconnected, and the four corners of the melter base have been connected to the GRE in accordance with Article 250 of NFPA 70-1999.	To be inspected during system walk down by engineering/construction.

3.15.3.5 Power Supplies for Electrodes Not Grounded

Requirement: The power supplies for the melter electrodes shall be ungrounded. [Section 8.8.1.2, BOD, [ID : DB-ENG-01-001 ID#10871]]

Basis Discussion: By extension of this requirement, the melt pool and all metal in contact with the melt pool must be electrically insulated from ground.

Power is supplied to the melter electrodes at about 300 V and 5000 amps. Current travels through the glass, causing it to heat up. This circuit is isolated from ground to eliminate any stray current paths. The circuit is said to be "floating above ground." All of the penetrations from the melt pool to or through the melter shell are insulated to maintain this isolation. A sheet of mica between the refractory and the melter shell isolates the grounded melter shell from the ungrounded refractory. The electrodes, bubblers assemblies, level detectors, and air lifts are all designed and constructed with isolation.

Other requirements for the melter electrode power supplies are listed in Section 3.13.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design provides for the power supplies, busses between the melter and the power supply, melt pool, bubbler and thermowell assemblies,	

Verif. Method	Verif. By	Plan	Notes/Comments
		level detectors, trough, dam, air lift lance, and electrode extensions to be isolated from ground.	
I	ENG	Review the design to verify that the design will not allow molten glass to form a path to ground when the glass moves through the riser, over the dam, and down the trough.	
I	SU/ COM	Review construction records to verify refractory, dam, trough and air lift lance are isolated from ground are electrically isolated from the melter shell.	
T	SU/ COM	Verify the melter electrode power supplies, as well as busses between the melter electrode power supplies and melters, remain ungrounded when the system is energized.	
I	ENG CON	Verify air lifts, level and density instruments, bubbler and thermowell assemblies and electrode extensions are isolated from ground.	Engineering/construction will inspect test during system walk down

3.15.3.6 Grounding Discharge and Startup Heaters

Requirement: The LAW melter discharge and startup heaters shall be grounded to the facility-grounding grid, system, GRE, in accordance with Article 250 of NFPA 70-1999 and electrically isolated from the melter structure. [Sections 8.8.1.3, 15.3.7, BOD, [ID : DB-ENG-01-001 ID#10878], [ID : DB-ENG-01-001 ID#12721]]

Basis Discussion: The discharge and startup heaters do not touch the melt pool so they do not make contact with the "floating" circuit described above in Section 3.15.3.5 of this SDD. These heaters are grounded through their respective power supplies. The startup heaters for both melters work off of the same power supply, LVE-PSUP-20101. See Section 3.12 for more information on the discharge and startup heaters.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify it includes provisions for connections of power supplies for the discharge and startup heaters to the GRE in accordance with Article 250 of NFPA 70-1999.	
I	ENG/ CON	Verify the power supplies for the discharge and startup heaters are connected to the GRE in accordance with Article 250 of NFPA 70-1999.	Engineering/construction will inspect test during system walk down.

3.15.3.7 Electrical Isolation of Discharge and Startup Heaters

Requirement: The LAW melter discharge and startup heaters shall be electrically isolated from the melter structure. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12721]]

Basis Discussion: The discharge and startup heaters need to be electrically isolated from the melter structure so the 480 V LVE does not short out to the ground.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify that the discharge and startup heaters are electrically isolated from the melter structure.	

3.15.4 Other Technical, Specialty, Operations and Maintenance Requirements

3.15.4.1 Modularization of Bubblers and Level Detectors - Consumable Component Changeout Requirements

Requirement: LMP system consumable components (i.e., those having a design life of less than 5 years; see Table 3-1) shall be modularized and otherwise designed for replacement and disposal to minimize onsite fabrication and replacement time. [Section 7.4, ORD, [ID : RPT-OP-01-001 ID#1132], [ID : RPT-OP-01-001 ID#1132]] [Sections 11.4.4, 15.3.1, 15.3.5, 15.3.3, BOD, [ID : DB-ENG-01-001 ID#11439], [ID : DB-ENG-01-001 ID#12694], [ID : DB-ENG-01-001 ID#12713], [ID : DB-ENG-01-001 ID#12701]]

Basis Discussion: As shown in Table 3-1, level detectors, bubblers, and thermocouples on the bubbler assemblies have an expected design life of only 1 year or less. This is because this equipment directly contacts the molten glass. Each time one of these instruments has to be changed out, the melter must be idled. By combining the instruments into an assembly, idle time of the melter is reduced.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the air lifts, level detectors, bubblers, and thermocouples , that form the bubbler assembly, are designed to be replaced and disposed of to minimize melter idle time.	Involve Operations with this inspection.
D	COM	Demonstrate bubbler assembly and level detectors change out.	This is also a demonstration requirement for Section 3.9.4.1.

3.15.4.2 Components Lifted with a Hook or Crane - Consumable Component Changeout Requirements

Requirement: LMP SSCs that exceed 50 lb in weight; operate at temperatures exceeding 140 °F (60 °C); or have sharp edges shall be designed with lifting bails. In addition, all removable components shall have lifting bails or allowances for remote handling. [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12715], [ID : DB-ENG-01-001 ID#12716]]

Basis Discussion: Consumable components will be moved with the assistance of a crane from the LSH system. Other equipment under this requirement are the shield lid covers that will be lifted to replace consumable components.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify startup heaters, air lifts, level and density instruments, bubbler and thermowell assemblies are designed with a lifting bail or a bail lift connecter that interfaces with the consumable change out box (CCB) that can carry the weight of the SSCs.	Document in an evaluation and assessment report.
I	ENG	Verify startup heaters and shield lid covers include lifting bails and allowances for remote handling.	

3.15.4.3 Cable Connections Through the Melter Enclosure

Requirement: Junction boxes shall be used to connect jumpers from instrumentation and discharge heaters within the melter enclosure to the cabling external to the melter enclosure. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12723]]

Basis Discussion: Junction boxes allow for the connection and disconnection of instrumentation without the need for workers to enter the C5V annulus.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the design includes junction boxes for all instrument connections through the melter enclosure.	

3.15.4.4 Cable Impact Requirements

Requirement: Cables routed inside of the melter enclosure shall be resistant to impact. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12723]]

Basis Discussion: The bubbler assemblies, which include plenum and melt pool thermocouples, include cabling for instrumentation. This cabling needs to be resistant to possible impacts with the sides of the shield lid's guide tubes.

Other cables, such as those for other instrumentation and feed lines, need to be evaluated for possible impacts from the consumable change out processes.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze the design to determine the impact loads on cables inside the melter enclosure.	
I	ENG	Review the design to verify cables are resistant to impact loads.	

3.15.4.5 Nonoxidizing Gas Purge

Requirement: The design shall provide a connection to a nonoxidizing gas to purge level and density probes and the air lift tubes. (B.1)

Basis Discussion: Argon is used to avoid the oxidizing potential of air injected into the molten glass through the level and density probes and the air lift tubes. The argon purge limits corrosion of the tubes and for the discharge riser, limits potential oxidation of the confined, lower-temperature glass. Oxidized glass, when heated, can undergo foaming. This functional requirement is based on experience with other melters. Report 24590-WTP-TQ-G-01-024, Rev 000, *Pours Caused by Glass Foaming*, sheds some light on the mechanics of potential glass foaming in the melter.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design to verify there is an argon gas connection to the level and density probes and air lift tubes.	

3.15.4.6 Temporary Lid Mounted Heaters for Startup

Requirement: The LMP system design shall include temporary lid mounted heaters to create the initial molten glass at melter startup. [Section 15.3.7, BOD, [ID : DB-ENG-01-001 ID#12720]]

Basis Discussion: Temporary heaters are used for the melter startup. These are mounted within the shield lid and removed after startup.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the design includes temporary heaters for melter startup.	

3.15.4.7 Piping ASME B31.3 Standard

Requirement: The LMP system piping design, fabrication, inspection, and testing of the piping shall be in accordance with ASME B31.3, *Process Piping*, 1996 edition, as tailored in Appendix C, Section C.26, of the Safety Requirements Document. [Sections 11.7.6, 11.7.1, BOD, [ID : DB-ENG-01-001 ID#13128], [ID : DB-ENG-01-001 ID#13129], [ID : DB-ENG-01-001 ID#13130], [ID : DB-ENG-01-001 ID#11516]] [Appendix C, Section C.26, SRD, [ID : SRD-ESH-01-001-02 ID#666]]

Basis Discussion: Although the LMP has non-safety portions of piping, ASME B31.3, Process Piping, 1996 edition, as tailored in Appendix C, Section C.26, of the Safety Requirements Document is used in all B31.3 pipe for design consistency.

The pipe, flanges, and valves are in accordance with the long stock code descriptions listed in applicable pipe class specifications used for the LMP. 24590-WTP-3PS-P000-T0001, *Engineering Specification for Piping Material Classes General Description and Summary* provides a summary listing of all the pipe class specifications used on WTP. Each pipe class sheet lists the design code used for the specific pipe class specification. The pipe, fittings, flanges, and valves used are in accordance with the design code listed on the specific pipe class specification. There are specific numbered in-line components provided by other engineering disciplines that are in accordance with the design code requirements listed in the applicable engineering specification for the specific component.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Perform an analysis of the piping design in accordance with ASME B31.3 (ed. 1996), as tailored in Appendix C, Section C.26 of the SRD.	
I	ENG	Review of the design to verify conformance to the analysis results.	Document in an evaluation/assessment that may be performed using a sampling basis or documented in DVR or RVM.

3.15.4.8 Piping Drainage and Slope

Requirement: LMP system piping shall be fully drainable and flushable with high point vents and low point drains and without traps or seals unless traps or seals will allow operator action for drainage. [Sections 7.1, 14.3, 20.0, ORD, [ID : RPT-OP-01-001 ID#1103], [ID : RPT-OP-01-001 ID#1477], [ID : RPT-OP-01-001 ID#1478], [ID : RPT-OP-01-001 ID#1725]]

Basis Discussion: Drainage and flushing capabilities are important for maintenance and decontamination activities.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the LMP fluid piping design (i.e., P&IDs) to confirm piping is designed to drain and flush.	
I	CON	Document inspection of installed lines to confirm draining and slope requirement.	

3.15.4.9 Prevention of Cross Contamination in Utility Piping

Requirement: The LMP system design shall include means to prevent or mitigate cross-contamination, including cases for unplanned siphoning or backflow. [Section 9.1, 7.1, ORD, [ID : RPT-OP-01-001 ID#1173], [ID : RPT-OP-01-001 ID#1102]]

Basis Discussion: None.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the utility connections will not allow cross contamination.	

3.15.4.10 Piping Utility Connections

Requirement: The LMP system design shall include engineered devices such as air gaps or adequate backflow preventers to utility connections. [Section 7.1, ORD, [ID : RPT-OP-01-001 ID#1100]]

Basis Discussion: None.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Verify the utility connections will not allow cross contamination.	Document in an evaluation and assessment report.

3.15.4.11 Piping Components Prone to Failure

Requirement: The LMP system design shall include provisions so that pump seals or other design features, upon failure, shall not provide a pathway for liquids or gases to personnel or to the environment. [Section 14.1, ORD, [ID : WTP-RPT-OP-01-001 ID#1468]]

Basis Discussion: None.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify components prone to failure are located so they do not create a pathway for liquids or gases that could lead to exposure to personnel or the environment when the components fail	

3.15.4.12 Pressure Relief Valves

Requirement: LMP system pressure relief valves shall be configured using a full port three-way valve, dual PSVs, and drain valves on each leg (unless a redundant train is provided). [Section 14.4, ORD, [WTP-RPT-OP-01-001 ID#1490]]

Basis Discussion: This configuration will preclude a service outage when servicing any relief valve.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify pressure relief valves are configured using a full port three-way valve, dual PSVs, and drain valves on each leg (unless a redundant train is provided).	

3.15.4.13 Labeling

Requirement: All LMP system valves shall be shown on design drawings and uniquely labeled in accordance with 24590-WTP-3DP-G03B-00044, *Standard Component Numbering*. All electrical equipment, containment systems, and cabling shall be provided and labeled with unique identification numbers. [Sections 14.4, 16.1, ORD, [ID : RPT-OP-01-001 ID#1491], [WTP-RPT-OP-01-001 ID #1609]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the valves, electrical equipment, containment systems, and cabling are labeled correctly.	

3.15.4.14 Periodic Inspections

Requirement: The LMP system shall permit appropriate periodic inspections and functional testing of:

- Electrical equipment such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components that reside outside of the melter shell.
- The operability and functional performance of system components, such as onsite power sources, relays, switches, and buses
- The operability of the systems as a whole under conditions as close to design as practical, including operation of protective systems, and the transfer of power between normal and backup systems
- Structural and leak-tight integrity of its piping components outside of the melter shell.
- Long term corrosion and/or organic fouling that could degrade system performance outside of the melter shell including impacts of organic fouling on heat exchanger performance.
- The potential for radioactive leakage into and out of the system and to the environment is minimized.
- The operability and the performance of the active components outside of the melter shell.
- The operability of the system as a whole including operation of applicable portions of the protection system and the transfer between normal and emergency power sources.

[Sections 14.3, 14.7, 16.1, ORD, [ID : RPT-OP-01-001 ID#1542], [ID : RPT-OP-01-001 ID#1500], [ID : RPT-OP-01-001 ID#1598], [WTP-RPT-OP-01-001 ID#1600]]

Basis Discussion: Components inside the melter shell will not be accessible for inspection. The estimated design life of these items has been based on the fact that these components will have to operate without inspection.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design documents of piping and electrical components outside of the melter shell are accessible for inspection and testing.	Operations should be consulted.

3.15.4.15 Reducing Maintenance

Requirement: The LMP system shall be designed with permanently lubricated, sealed for life components to reduce maintenance requirements. [Section 9.1, ORD, [ID : RPT-OP-01-001 ID#1172]] [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12712]]

Basis Discussion: None.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analyze SSCs requiring lubrication and /or seals and determine if permanently lubricated, sealed for life components can be used in those applications.	
I	ENG	Review the design to verify permanently lubricated, sealed for life components are designated where their use is applicable.	

3.15.4.16 Worker Safety

Requirement: The LMP system nonstructural SSCs shall conform to industrial safety requirements in accordance with 29 CFR 1910, *Occupational Safety and Health Standards*. [Section 9.1, ORD, [ID : RPT-OP-01-001 ID#1178], [ID : RPT-OP-01-001 ID#1174], [ID : RPT-OP-01-001 ID#1186]] [Section 15.3.5, BOD, [ID : DB-ENG-01-001 ID#12712]]

Basis Discussion: The LMP is designed to allow access to equipment where hands-on maintenance does not compromise worker safety, room for ladders and lifts to access equipment and instruments 5 ft above floor level, and adequate clearances around equipment to accommodate maintenance and operation personnel and their portable equipment and personal protective equipment shall be included in the LMP system design. Equipment and instruments requiring personnel access for periodic calibration or maintenance is located in areas where personnel exposure is as low as reasonably achievable. Radiation exposure to personnel in the melter gallery is covered in Section 3.5 of this SDD.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the LMP design to verify it allows for safe and effective maintenance.	Coordinate with operations to document in an evaluation and assessment report.
I	ENG	Review the design to verify SSCs requiring personnel access for periodic calibration or maintenance shall be located in areas where personnel exposures are ALARA.	Document in an evaluation and assessment. Radiological Engineering to participate in and/or review the evaluation and assessment.

3.15.4.17 Test Points

Requirement: The design shall include isolation and test points, including drain and bleed valves on piping, to allow for removal, replacement, and testing of plant items required during normal operations. [Section 9.1, ORD, [ID : RPT-OP-01-001 ID#1173]] [Sections 11.5.1, 15.3.5, BOD, [ID : DB-ENG-01-001 ID#11459], [ID : DB-ENG-01-001 ID#12712]]

Basis Discussion: None.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design documents to verify accessible test points, including drain/bleed valves, exist where needed.	

3.15.4.18 Lockout/Tagout

Requirement: The design shall provide provisions for lockout/tagout operations as discussed in Section 19.14 of the ORD. [Section 19.14, ORD, [ID : RPT-OP-01-001 ID#1714], [WTP-RPT-OP-01-001 ID#1599]]

Basis Discussion: None.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review design documents to verify operators have a means to lockout/tagout energized systems for maintenance.	SU and COM should be consulted.

3.15.4.19 Decontamination

Requirement: The LMP system equipment subject to decontamination, including cooling water piping systems, shall withstand this process without any reduction of functionality through degradation of the electrical, mechanical, or any other components involved. [Sections 9.1, 14.7, ORD, [ID: WTP-RPT-OP-01-001 ID#1171], [ID: WTP-RPT-OP-01-001 ID#1505]]

Basis Discussion: Equipment operating in a contaminated environment is monitored and, if necessary, decontaminated before maintenance. The specifications must convey that the equipment design accounts for these processes.

This requirement applies to instrumentation, piping and electrical equipment outside of the melter enclosure. The exterior of the melter enclosure will be the only part of an actual melter that will be decontaminated. The requirements for decontamination of the melter enclosure are in Section 3.9.4.3 of this SDD.

[ALARA]

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the LMP design to verify equipment/components subject to decontamination can withstand decontamination without degradation or reduction in equipment functionality	

3.15.4.20 Startup Testing and Commissioning

Requirement: The system design shall include provisions, as necessary, to support startup and commissioning testing as identified in Appendix A. [Section 11.4.7, 11.5.1, BOD, [ID : DB-ENG-01-001 ID#11448], [ID : DB-ENG-01-001 ID#11459]] [Section 9.1, ORD, [ID : RPT-OP-01-001 ID#1173]]

Basis Discussion: Additional nozzles, branch lines, removable spools or other provisions that are needed to support identified testing are to be provided, as jointly determined by the Design Agency, startup, and commissioning during the design development and review process, with consideration given to tests and demonstration activities required for requirement verifications specified in Appendix A. This may include, but is not limited to, provisions to support the introduction or removal of fluids, gases, reagents or simulants; or the availability of special test ports, sampling ports, or temporary instruments or instrument lines.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Analysis of the LMP system to determine the provisions needed to support tests/demonstrations to be performed during startup and commissioning.	Document in an assessment and evaluation report. SU and COM to participate in the assessment and evaluation.
I	ENG	Review design to verify requirement is met based on established tests and demonstrations to be performed during SU and COM.	Document in an assessment and evaluation report.

3.15.4.21 Design for Replacement after End of Life or Failure

Requirement: The LAW melter shall be removable from the LAW Facility upon the end of life or failure. [Sections 11.3.2.1, 15.3.1, BOD, [ID : DB-ENG-01-001 ID#11394], [ID : DB-ENG-01-001 ID#12691]] [Section 11.1.1, BOD, [ID : DB-ENG-01-001 ID#11367]]

Basis Discussion: The design life of the melter is 5 years (see Section 3.4.1.4) while the design life of the LAW Facility is 40 years. Therefore, the melter must facilitate removal and replacement. Under normal operating conditions, the melters are anchored to rails in the LAW Facility. When the melter needs to be replaced, the anchors will be removed and the melter will be rolled out of the facility along the rails. The LAW melter handling system (LMH) will perform removal and replacement.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Define components needed on the melter so the melter can interface with the LMH system.	Refer to Appendix B, 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters.*
I	ENG	Verify the design of the melter wheels correspond with the melter rails located in the LAW Facility and other components defined in the analysis are included in the design.	

3.15.4.22 Provide Drains

Requirement: The design shall include a drain in the melter base in the annular space and a drain in the melter base between the melter shell and the melt pool refractory. (F.1)

Basis Discussion: The drains prevent the backup of water in the event of a cooling water leak or other uncontrolled addition of water from other sources.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify the design includes the necessary drains.	Document in a DVR.

3.15.4.23 Power Supply Transformers

Requirement: Transformers inside power supplies shall be dry type. [Section 8.4.3, BOD, [ID : DB-ENG-01-001 ID#10745]] [Section 16.1, ORD, [ID : WTP-RPT-OP-01-001 ID#1608]]

Basis Discussion: Section 16.1 of the ORD states that transformers may be liquid filled for outdoor service, or dry type for indoor use.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the vendor data to verify LVE and MVE power supplies in LMP are the dry type.	

3.15.4.24 Provide E-Stops

Requirement: Dedicated emergency-stop (E-Stop) buttons shall be provided near machinery where physical injury is credible. Each individual E-Stop provided in LMP, however configured, shall report its individual status back to its control system (e.g., ICN receives E-Stop status for ICN controlled equipment, non-ICN controlled equipment E-Stop status is reported to its non-ICN control system). [Section 11.12.5.3, ORD, [WTP-RPT-OP-01-001 ID#1348]]

Basis Discussion: E-Stops are required to send individual status back to its control system for diagnostic purposes.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
A	ENG	Review the design of electrical equipment in LMP to determine what machinery could cause a credible injury.	Engineering will work with Operations to make this determination.
I	ENG	Review the design to verify machinery that is determined to cause a credible injury has an E-Stop.	
I	ENG	Review the design to verify each individual E-Stop provided in the plant, however configured, report its individual status back to its control system.	

3.15.4.25 Remote Valves

Requirement: Remote operation of valves shall be provided where accessibility is difficult, and for valves used in routine operations. [Section 14.4, ORD, [ID: WTP-RPT-OP-01-001 ID#1485]]

Basis Discussion: Air lift lance air valves are remotely operated.

Verification: Verification is expected to be achieved through the following:

Verif. Method	Verif. By	Plan	Notes/Comments
I	ENG	Review the design to verify remote operated valves are provided where accessibility is difficult.	

3.16 Relevant Codes and Standards

3.16.1 Codes of Record

The table below identifies relevant external codes and standards applicable to the LMP design. These are selected from those documents that comprise the Code of Record as established in 24590-WTP-RPT-ENG-01-001, *Technical Baseline Description* (i.e., the WTP Contract, the BOD and the SRD). Use of these documents is typically invoked in the design process through the documents identified in Section 3.16.2 of this SDD. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from these documents for allocation to SSCs.

In some cases, the expected means of verification may be established on the basis of tests or other criteria required by the codes and standards. This does not necessarily include verification or testing more appropriately defined in the procurement of individual subsystems or components, or verification or testing that is a routine activity defined by specifications and/or procedures used by construction and startup.

Table 3-5 LAW Melter Process System Applicable Codes and Standards

Implementing Codes and Standards: [Contract No. DE-AC27-01RV14136, WTP Contract, DOE 2000]
• 40 CFR 268., *Land Disposal Restrictions.* Code of Federal Regulations.
Implementing Codes and Standards: [24590-WTP-DB-ENG-01-001, Rev 2, Basis Of Design]
• 10 CFR 830, *Nuclear Safety Management.* Code of Federal Regulations.
• 10 CFR 835, *Occupational Radiation Protection.* Code of Federal Regulations.
• 29 CFR 1910, *Occupational Safety and Health Standards.* Code of Federal Regulations.
• 29 CFR 1910, Subpart D, *Occupational Safety and Health Administration*; Walking – Working Surfaces, as amended. Code of Federal Regulations.
• 29 CFR 1910, Subpart S, *Occupational Safety and Health Administration*; Electrical, as amended. Code of Federal Regulations.
• ASCE 7-98. *Minimum Design Loads in Building and Other Structures.* American Society of Civil Engineers, Reston, VA..
• ASME B31.3. 1996. *Process Piping*, American Society of Mechanical Engineers, New York, NY.
• ASME. 2001 *ASME Boiler and Pressure Vessel Code*, Section VIII. American Society of Mechanical Engineers, New York, NY.
• AWS D1.1, *Structural Welding Code*; Steel. American Welding Society, Miami, FL.
• AWS D1.6, *Structural Welding Code*; Stainless Steel. American Welding Society, Miami, FL.
• ICBO. 1997. *Uniform Building Code.* International Council of Building Officials, Whittier, CA.
• ICC 2000, *International Building Code.* International Code Council, Washington, DC.
•
• IEEE Standard 1202. 1991. *Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.* Institute of Electrical and Electronics Engineers, New York, NY.
• IEEE Standard 141. 1986. *Recommended Practice for Electric Power Distribution for Industrial Plants.* Institute of Electrical and Electronics Engineers, New York, NY.

Table 3-5 LAW Melter Process System Applicable Codes and Standards

• IEEE Standard 260.1. 1993. *American National Standard Letter Symbols for Units of Measurement.* Institute of Electrical and Electronics Engineers, New York, NY.
• IEEE Standard 315. 1993. *Graphic Symbols for Electrical and Electronics Diagrams.* Institute of Electrical and Electronics Engineers, New York, NY.
• IEEE Standard 338, *Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems.* Institute of Electrical and Electronics Engineers, New York, NY.
• IEEE Standard 384, *Standard Criteria for Independence of Class 1E Equipment and Circuits.* Institute of Electrical and Electronics Engineers, New York, NY.
• NEMA WC. 1999. *Wire and Cable Standards.* National Electric Manufacturers Association, Rosslyn, VA.
• NEMA/ICEA (Insulated Cable Engineers Association). 1999. *Power Cable Ampacities.* National Electric Manufacturers Association, Rosslyn, VA.
• NFPA 497. 1997. *Recommended Practice for Classification of Hazardous Locations for Electrical Installations in Chemical Process Areas.* National Fire Protection Association, Quincy, MA.
• NFPA 70. 1999. *National Electrical Code.* National Fire Protection Association, Quincy, MA.
• NFPA 801. 2003, *Standard for Fire Protection for Facilities Handling Radioactive Materials* National Fire Protection Association, Quincy, MA..
• UBC. 1997. *Uniform Building Code.*
• UL 508. 1999. *Standard for Safety Electrical Industrial Control Equipment.* Underwriters Laboratories, Northbrook, IL.
• WAC 173-303, *Washington Administrative Code - Dangerous Waste Regulations.*
Implementing Codes and Standards: [24590-WTP-SRD-ESH-01-001-02, Rev 7f, Safety Requirements Document Volume II, (SRD)]
• AISC M016-89, *Manual for Steel Construction - Allowable Stress Design, Ninth Edition*, as tailored in Appendix C.
• ANSI/ANS 58.8 1994, *Time Response Design Criteria for Safety Related Operator Actions.* American Natioanl Standards Institute, New York, NY.
• ANSI/ISA 67.04.01-2006, *Setpoints for Nuclear Safety-Related Instrumentation*, as tailored in Appendix C.
• ANSI/ISA S84.01, *Application of Safety Instrumented Systems for Process Industries.* American Natioanl Standards Institute, New York, NY.
• ASCE 4-98, *Seismic Analysis of Safety-Related Nuclear Structures and Commentary.* American Society of Civil Engineers, Reston, VA.
• ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures.* American Society of Civil Engineers, Reston, VA.
• DOE G 420.1-1, *Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for Use with DOE O 420.1, Facility Safety Section 2.3.*
• DOE Order 420.1B, *Facility Safety*, as tailored in Appendix C.
• DOE Newsletter (Interim Advisory on Straight Winds and Tornados) Dated 1/22/98.
• DOE-STD-1020-94 (Change 1, 1996), *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, as tailored in Appendix C.
• DOE-STD-1021-93 (Reaffirmed with Errata April 2002), *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components, Section 2.4, Basic Categorization Guidelines, Section 2.5, System Interaction Effects ("Two Over One Protection").*
• IEEE 323-83, *Qualifying Class 1E Equipment for Nuclear Power Generating Stations*, as tailored in Appendix C.
• IEEE 338-1987, *Standard Criteria for the Periodic Surveillance Testing of Nuclear Power Generating Station Safety Systems,* as tailored in Appendix C.
• IEEE 344-1987 (R1993), *Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations,* as tailored in Appendix C.

Table 3-5 LAW Melter Process System Applicable Codes and Standards

• IEEE 382-1996, *Standard for Qualification of Actuators for Power-Operated Valve Assemblies With Safety-Related Functions for Nuclear Power Plants.*
• IEEE 1023-88, *Guide for the Application of Human Factors Engineering to System, Equipment, and Facilities of Nuclear Power Generating Stations,* as tailored in Appendix C.
Implementing Codes and Standards: [24590-WTP-RPT-OP-01-001, Rev 5, Operations Requirements Document, (ORD)]
• NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum).* National Electric Manufacturers Association, Reston, VA.

3.16.2 WTP Design Criteria, Design Guides, and General Specifications

Table 3-6 identifies relevant discipline design criteria, guides, and general specifications applicable to the LMP system. Use of these documents to develop the detailed design of SSCs is governed by engineering procedures. The majority of requirements within this document are derived from external codes and standards, or are specified methods and approaches to achieve standardization and consistency of design. Beyond inclusion here, no attempt is made in this document to extract individual design requirements from these documents for tracing and verification, or to define how direction provided by these documents is applicable and allocated (or not) to individual SSCs.

Table 3-6 WTP Design Criteria, Design Guides, and General Specifications Applicable to LMP

Document Number	Title
Design Criteria Documents:	
24590-WTP-DC-E-01-001	Electrical Design Criteria
24590-WTP-DC-E-06-001	Design Criteria for Approval of Electrical Equipment
24590-WTP-DC-E-06-002	Design Criteria for Independence of Safety Equipment and Circuits
24590-WTP-DC-E-06-003	Design Criteria for Implementation of IEEE 628 for Raceway Systems
24590-WTP-DC-E-07-001	Design Criteria for Electrical Jumpers
24590-WTP-DC-E-09-001	Design Criteria for Electrical Equipment Installations
24590-WTP-DC-ENG-06-001	Design Criteria for Environmental and Natural Phenomena Hazard Qualification of Structures System and Components
24590-WTP-DC-M-06-001	Mechanical System Design Criteria
24590-WTP-DC-PS-01-001	Pipe Stress Design Criteria Including "Pipe Stress Criteria" and "Span Method Criteria"
24590-WTP-DC-PS-01-002	Pipe Support Design Criteria
24590-WTP-DC-ST-01-001	Structural Design Criteria
24590-WTP-DC-ST-04-001	Seismic Analysis and Design Criteria
Design Guides:	
24590 WTP GPP SQP 208	Plant Software Lifecycle
24590-WTP-GPG-E-0006	Electrical Equipment Installations Working and Dedicated Space Evaluation
24590-WTP-GPG-E-001	Setroute Work Process
24590-WTP-GPG-E-002	Electrical Design Document Checking and Change Control
24590-WTP-GPG-ENG-004	Design Guide Pipe Stress, Pipe Layout, and Support Spacing
24590-WTP-GPG-ENG-005	Engineering Design Guide for Pipe Support
24590-WTP-GPG-ENG-0094	Pipe Design Work Process

Table 3-6 WTP Design Criteria, Design Guides, and General Specifications Applicable to LMP

Document Number	Title
24590-WTP-GPG-ENG-0098	Melter Engineering Document Transmittal Process
24590-WTP-GPG-ENG-0103	Equipment Seismic Qualification
24590-WTP-GPG-ENG-0109	Accessibility Review of Equipment and Components
24590-WTP-GPG-ENG-0111	Intools Data Entry for Process Data
24590-WTP-GPG-ENG-0118	Piping Component Stock Codes
24590-WTP-GPG-ENG-0127	Processing Engineering Calculations
24590-WTP-GPG-ENG-0141	WTP Radiation Damage Thresholds for Non-Metallic Materials
24590-WTP-GPG-ENG-0144	Piping Interface with Flexible Equipment-Stress Analysis Design Guide
24590-WTP-GPG-ENG-0145	SC-IIIE Piping - Stress Analysis Design Guide
24590-WTP-GPG-ENG-0146	Piping Coating System Selection Guide
24590-WTP-GPG-ENG-0148	Data Sheet Development, Maintenance and Use
24590-WTP-GPG-ENG-0149	Piping Classification Guide
24590-WTP-GPG-ENG-0150	Plant Design/Mechanical System Equipment Interfaces: Terminal End Equipment
24590-WTP-GPG-ENG-0153	Safety Instrumentation - Independent Protection Layer Identification
24590-WTP-GPG-ENG-0159	Single Failure Analysis Process for Mechanical, HVAC, and Control System
24590-WTP-GPG-ENG-0165	Pipe Stress and Supports Confirmation
24590-WTP-GPG-ENG-033	Evaluation for Seismic Interaction Effects
24590-WTP-GPG-ENG-086	Equipment Environmental Qualification
24590-WTP-GPG-J-005	Control System Interfaces
24590-WTP-GPG-J-0057	Setpoint Calculations
24590-WTP-GPG-J-014	Control System Design Process Guide
24590-WTP-GPG-J-015	Safety Instrumented System Implementation
24590-WTP-GPG-J-016	Control Valve Sizing
24590-WTP-GPG-J-017	WTP Seismic Category Application to C&I System
24590-WTP-GPG-J-022	Design Verification for Controls & Instrumentation
24590-WTP-GPG-M-002	Hydraulic Seals
24590-WTP-GPG-M-0059	Avoiding Chemical Line Plugging - Plant Design Considerations
24590-WTP-GPG-M-0061	Vessel Structural Analysis and ASME Section VIII Evaluation
24590-WTP-GPG-M-0067	Mechanical Systems Engineering Documentation of ASME B31.3 Unlisted Components
24590-WTP-GPG-M-010	Pipe Sizing Using Pipe-Flo Software Packages
24590-WTP-GPG-M-011	Pipe Sizing for Compressible Flow
24590-WTP-GPG-M-016	Pipe Sizing for Lines With Liquids Containing Solids - Bingham Plastic Model
24590-WTP-GPG-M-017	Design Parameters & Test Pressures for Equipment & Piping
24590-WTP-GPG-M-019	Vessel Sizing
24590-WTP-GPG-M-021	Thermal Insulation
24590-WTP-GPG-M-022	Liquid and Vapor Line Sizing By formula
24590-WTP-GPG-M-023	Other Losses In Piping System
24590-WTP-GPG-M-027	Recommended Slopes for Piping System
24590-WTP-GPG-M-028	Vent, Drain, and Root Valve Sizing and Selection for Piping System
24590-WTP-GPG-M-030	P&ID Development

Table 3-6 WTP Design Criteria, Design Guides, and General Specifications Applicable to LMP

Document Number	Title
24590-WTP-GPG-M-032	Vessel Overflow and Gravity Line Sizing
24590-WTP-GPG-M-034	Sizing Safety Relief Devices and Relief System Design
24590-WTP-GPG-M-036	Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts
24590-WTP-GPG-M-046	Component Information System (Cis)
24590-WTP-GPG-M-047	Preparation of Corrosion Evaluations
24590-WTP-GPG-M-050	Pressure Vessel and Heat Exchanger Design
24590-WTP-GPG-M-051	Preparing Confirmed Calculations
24590-WTP-GPG-M-052	Specifying Design Cycles for Equipment and Piping
24590-WTP-GPG-P-002	Guide for Procurement of Jumpers and Related Equipment Using the Basic Order Agreement (BOA)
24590-WTP-GPG-P-003	Jumper Design Guide
24590-WTP-GPG-PL-002	Plant Design Material Control Guide
24590-WTP-GPG-SRAD-001	Design Guide for ALARA
24590-WTP-GPP-SQP-200	Acquisition and Management of Safety Plant Installed Software
24590-WTP-GPP-SQP-204	Acquired Software Packaged with Equipment
24590-WTP-GPP-SRAD-007	Classification of Areas
Specifications:	
24590-WTP-3PS-E00X-T0001	Engineering Specification for Electrical Equipment Installation
24590-WTP-3PS-E00X-T0003	Engineering Specification for Cable Terminations
24590-WTP-3PS-E00X-T0004	Engineering Specification for Installation of Cables
24590-WTP-3PS-E00X-T0005	Engineering Specification for Electrical Raceway and Cable Identification
24590-WTP-3PS-E00X-T0007	Engineering Specification for Electrical Raceway System Installation
24590-WTP-3PS-EBB0-T0001	Engineering Specification for Busway and Supports
24590-WTP-3PS-EEC1-T0002	Engineering Specification for HLW & LAW Pour Head CCTV Cameras
24590-WTP-3PS-EEC1-T0003	Engineering Specification for Process and Mechanical Handling CCTV Through Barrier Remote-Viewing Camera Units.
24590-WTP-3PS-EED1-T0005	Engineering Specification for 480v Dual Automatic Transfer Switches and Panelboards
24590-WTP-3PS-EKP0-T0001	Engineering Specification for Electrical Requirements for Packaged Equipment
24590-WTP-3PS-EW00-T0001	Engineering Specification for Power, Control and Instrumentation Cable, Medium Voltage Power Cable and Fiber Optic Cable (Safety)
24590-WTP-3PS-EWY0-T0001	Engineering Specification for Electrical Jumper Fabrication (Non-Its)
24590-WTP-3PS-EY00-T0002	Engineering Specification for Hanford Electrical Jumper Connector Cast Mechanical Components
24590-WTP-3PS-EY00-T0003	Engineering Specification for Heater Power Supply
24590-WTP-3PS-FB01-T0001	Engineering Specification for Structural Design Loads for Seismic Category III & IV Equipment and Tanks
24590-WTP-3PS-G000-T0006	Engineering Specification for Preserving, Packaging, and Preparing Melter and Melter Components for Shipping, Handling, and Storage
24590-WTP-3PS-G000-T0014	Engineering Specification for Supplier Design Analysis
24590-WTP-3PS-G000-T0015	Engineering Specification for Environmental Qualification of Mechanical Equipment
24590-WTP-3PS-G000-T0018	Engineering Specification for Flushing and Cleaning Requirements for The Startup of Quality and Commercial Fluid Systems In All Facilities

Table 3-6 WTP Design Criteria, Design Guides, and General Specifications Applicable to LMP

Document Number	Title
24590-WTP-3PS-G000-T0019	Engineering Specification for Acquisition of Commercial Items and Services for Use In Safety Applications At WTP
24590-WTP-3PS-G000-T0045	Engineering Specification for Supplier Design Analysis With Developed Software
24590-WTP-3PS-J000-T0001	Melter Systems C&I Work Specification
24590-WTP-3PS-JD01-T0001	Engineering Specification for Plant Wide Control Systems (Integrated Control Network)
24590-WTP-3PS-JL24-T0002	Engineering Specification for LAW Primary Container Level Detection System
24590-WTP-3PS-JP02-T0001	Engineering Specification for Radiation Tolerant Pressure Transmitter Gauge, Absolute, Or Differential Pressure Measurements
24590-WTP-3PS-JP02-T0002	Engineering Specification for Radiation Tolerant Pressure Transmitter Gauge Absolute Or Differential Pressure Measurements
24590-WTP-3PS-JP02-T0003	Engineering Specification for Transmitters for Gauge, Absolute, Differential Pressure, Level and Flow Measurement
24590-WTP-3PS-JP02-T0004	Engineering Specification for Transmitters for Gauge Absolute Differential Pressure Level and Flow Measurements
24590-WTP-3PS-JP02-T0005	Engineering Specification for Passive Safety Functions Pressure Transmitters
24590-WTP-3PS-JQ00-T0004	Engineering Specification for Management of Supplier Software
24590-WTP-3PS-JQ00-T0005	Engineering Specification for Management of Supplier Safety Software
24590-WTP-3PS-JQ00-T0006	Engineering Specification for Management of Supplier Developed Safety Software for Safety Instrumented Functions
24590-WTP-3PS-JQ06-T0005	Engineering Specification for Environmental Qualification of Control and Electrical Systems and Components
24590-WTP-3PS-JQ06-T0006	Engineering Specification for Instrumentation With Passive Safety Functions
24590-WTP-3PS-JQ07-T0001	Engineering Specification for Instrumentation for Packaged Systems
24590-WTP-3PS-JQ08-T0001	Engineering Specification for Construction and Installation of Controls and Instrumentation
24590-WTP-3PS-JV01-T0001	Engineering Specification for Control Valves
24590-WTP-3PS-JV01-T0003	Engineering Specification for Control Valves (QL)
24590-WTP-3PS-JV09-T0001	Engineering Specification for On/Off Instrument Valves - ITS
24590-WTP-3PS-JXF0-T0001	Engineering Specification for Instrument Piping Material Classes
24590-WTP-3PS-JXF0-T0002	Engineering Specification for Instrument Piping Material Classes - Q
24590-WTP-3PS-JXF0-T0003	Engineering Specification for Instrument Tubing Supports - QL
24590-WTP-3PS-JXH0-T0001	Engineering Specification for Instrumentation Flexible Metal Hoses
24590-WTP-3PS-JXXE-T0002	Engineering Specification for C&I Enclosures, Panels, Cabinets, and Racks
24590-WTP-3PS-JXXE-T0003	Engineering Specification for Commercial C&I Enclosures, Panels, Cabinets, and Racks
24590-WTP-3PS-JZ02-T0001	Engineering Specification for Radiation Tolerant Proximity
24590-WTP-3PS-LVE-T0001	Engineering Specification for Electrical and Instrumentation Jumper Cables
24590-WTP-3PS-LVE-T0002	Engineering Specification for Insulating Plates and Contacts
24590-WTP-3PS-LVE-T0003	Engineering Specification for Electrical and Instrumentation Jumper Connectors
24590-WTP-3PS-LVE-T0006	Engineering Specification for Electrical and Instrumentation Jumper Connectors
24590-WTP-3PS-M000-T0013	Engineering Specification for Small Catalog Components, Consumables, Shims and Lubricants for Mechanical Equipment
24590-WTP-3PS-M000-T0014	Engineering Specification for Labeling of Permanent Plant Components
24590-WTP-3PS-MEEM-T0001	Engineering Specification for Melter Start-Up Frit

Table 3-6 WTP Design Criteria, Design Guides, and General Specifications Applicable to LMP

Document Number	Title
24590-WTP-3PS-MEHU-T0001	Technical Specification for Unit Heaters
24590-WTP-3PS-MEP0-T0001	Engineering Specification for Plate and Frame Heat Exchangers
24590-WTP-3PS-MPC0-T0002	Engineering Specification for General Centrifugal Pumps To Meet Requirements of ASME B73.1M-2001 and ASME B73.2M-2003 for Commercial (CM) Components
24590-WTP-3PS-MTSS-T0001	Engineering Specification for Tank Welding
24590-WTP-3PS-MV00-T0001	Engineering Specification for Pressure Vessel Design and Fabrication
24590-WTP-3PS-MV00-T0002	Engineering Specification for Seismic Qualification Criteria for Pressure Vessels
24590-WTP-3PS-MV00-T0003	Engineering Specification for Pressure Vessel Fatigue Analysis
24590-WTP-3PS-MVB2-T0001	Engineering Specification for Welding of Pressure Vessels, Heat Exchangers and Boilers
24590-WTP-3PS-NWP0-T0001	Engineering Specification for General Welding and NDE Requirements for Supplier Fabricated Piping
24590-WTP-3PS-P000-T0001	Engineering Specification for Piping Material Classes General Description and Summary
24590-WTP-3PS-PB01-T0001	Engineering Specification for Technical Supply Conditions for Pipe, Fittings, and Flanges
24590-WTP-3PS-PH01-T0001	Engineering Specification for Technical Supply Conditions 'QL' Pipe Supports
24590-WTP-3PS-PH01-T0002	Engineering Specification for Installation of Pipe Supports
24590-WTP-3PS-PS02-T0001	Engineering Specification for Shop Fabrication of Piping
24590-WTP-3PS-PS02-T0003	Engineering Specification for Field Fabrication and Installation of Piping
24590-WTP-3PS-PS02-T0003	Engineering Specification for Field Fabrication and Installation of Piping
E24590-WTP-3PS-PV00-T0001	Engineering Specification for Technical Supply Conditions for Valves
24590-WTP-3PS-SS00-T0001	Engineering Specification for Welding of Structural Carbon Steel
24590-WTP-3PS-SS00-T0002	Engineering Specification for Welding of Structural Stainless Steel and Welding of Structural Carbon Steel to Stainless Steel
24590-WTP-3PS-SS01-T0002	Engineering Specification for Purchase of Structural Steel
24590-WTP-3PS-SS02-T0001	Engineering Specification for Erection of Structural Steel
24590-WTP-3PS-SS90-T0002	Engineering Specification for WTP Project Tailoring of ANSI/AISC N690 & IEEE 323, 344 & 382
24590-WTP-3PS-SY00-T0001	Engineering Specification for Purchase of Standard Struts, Fittings, and Accessories

4 System Description

This section summarizes design output information, describing the current design and the operational and maintenance aspects of the system. The information provided in the following sections does not contain design requirements and should not be used as design input. The description of the current design contained in this section may not fully align with design requirements. This is acceptable within the context of this document. Areas of misalignment are to be resolved through appropriate mechanisms and the SDD updated to reflect changes made to the design. Changes to the descriptive text will be made following the changes to the lower-tiered Engineering documents.

4.1 Configuration Information

The LMP system consists of the LAW melter and its appurtenances. The melter shield box is located in the melter gallery as an assembly of components and interfaces, which process the LAW feed stream into glass.

The LMP system (located on the 3 ft and higher level of the LAW Facility) is designed to convert the mixture of the pretreated LAW and glass-forming chemicals into glass (or ILAW) and is considered a Miscellaneous Unit (as defined in the Dangerous Waste Permit WAC 173-303). The LAW melters are located at the south side of the 3 ft elevation level of the LAW Facility, inside the melter gallery (which is an R3/C3 area). The melter gallery holds two melters, each with a design life of 5 years. This design life is consistent with typical joule-heated melter performance considering the nature of the feed, and considered reasonable with respect to current technology, ALARA principles, and waste minimization. The melter is designed to withstand the corrosive environment caused by the melter feed, molten glass, and offgases for the component lifetimes given in the melter specification, 24590-LAW-3PS-AE00-T0001, *Engineering Specification for Low Activity Waste Melters*. All materials chosen for design of the melter have been evaluated with respect to surface finish, chemical resistance, radiation resistance, pressure effects, temperature effects, hardness, and fatigue as appropriate for the environment of the melter.

4.1.1 Description of System, Subsystems, and Major Components

4.1.1.1 Locally Shielded Melter

The LAW melter is a self-shielded package designed for local, hands-on operation and maintenance. Elements of the melter are described individually and collectively to implement melter functions. Also see Section 1.5 of this SDD, Definitions and Glossary. Functions and structures do not always provide a one-to-one correspondence for the melter package.

4.1.1.2 Containment

The LAW melter package contains molten glass and process offgases as well as the resultant heat, contamination, and radiation. The containment involves multiple physical layers and two ventilation systems. Starting from the inside, the physical barriers include the refractory, a gas barrier wall, and the exterior shield wall. The gas barrier (walls, floor and lid) together with supporting structure provide the melter shell, which is the credited confinement boundary. A support structure of tubular beams is built up on the outside of the gas barrier. The structure houses utility piping and supports the entire package, including the exterior shielding. Process offgas (systems LOP and LVP) and C5 ventilation systems remove gases and purge the melter. Finally, cooling water and air maintain the desired temperature gradient across the package. The gas barrier is not a pressure boundary; leakage paths from C5 area to the process offgas, purge, and cool the package.

The refractory is set in the gas barrier metal box, which provides the containment of the process. The box is fabricated with corrosion resistant metal, Inconel 690. Within the box, a refractory package provides the chemical and thermal barriers to contain the molten glass and process gases. Water cooled panels back up the refractory, removing heat to define the thermal gradient across the refractory and to limit the heat load on the ventilation system.

4.1.1.3 Refractory

The LAW melter utilizes a multicomponent system of refractory is used to provide both the corrosion resistance and the insulation properties required to meet design goals. The various refractory products used in the melter include the following:

- Monofrax H block – high alumina, fused cast refractory used in plenum lining. Durable to volatile glass components and offgas; resistant to thermal shock.
- Monofrax K3 block – alumina and chromia fused cast refractory used as primary glass contact brick. Resistant to corrosion by glass.
- Monofrax E block – high chromia fused cast refractory used in high wear locations (riser block). Highly resistant to wear and glass corrosion but electrically conductive so that it is not appropriate for general use in electrically heated melter.
- AZS brick – alumina, zirconia, and silica brick; backup refractory, with a higher insulating value than K3.
- Greencast 94 – castable alumina refractory, low thermal conductivity. Used on the melter floor to level bed for brick [Greencast 94F].
- Mica paper – high electrical resistance.
- Kaolite 2500-LI – castable alumina; silica refractory used to backup plenum refractory in gas barrier lid, and in places at discharge.
- Versaflow 57A – castable low density and low thermal conductivity. Used behind the Kaolite in the lid. [Versaflow 57A Plus]
- Duraboard HD – fiber board, very low thermal conductivity. Used as outer layer in discharge and gas barrier lid. Crushable with thermal expansion of other refractory in discharge section.

NOTE: The product names used above reflect specific choices made during the design phase. In some cases equivalent products are available and may be purchased for the assembly. When known, equivalent products will be listed in brackets [] and the main text will use the "as designed" designations.

The major melter components are the main cavity and the lid. Main cavity refractory can be divided into three distinct areas: glass pool, with the hot wall and discharge discussed separately, and the plenum. Each area features different structures and refractory combinations to attain chemical resistance and thermal profile requirements. Figure 4-1 is a section view of the LAW melter and discharge chamber with major components identified. Note that color assignments in Figure 4-1 do not correlate with the different refractory types.

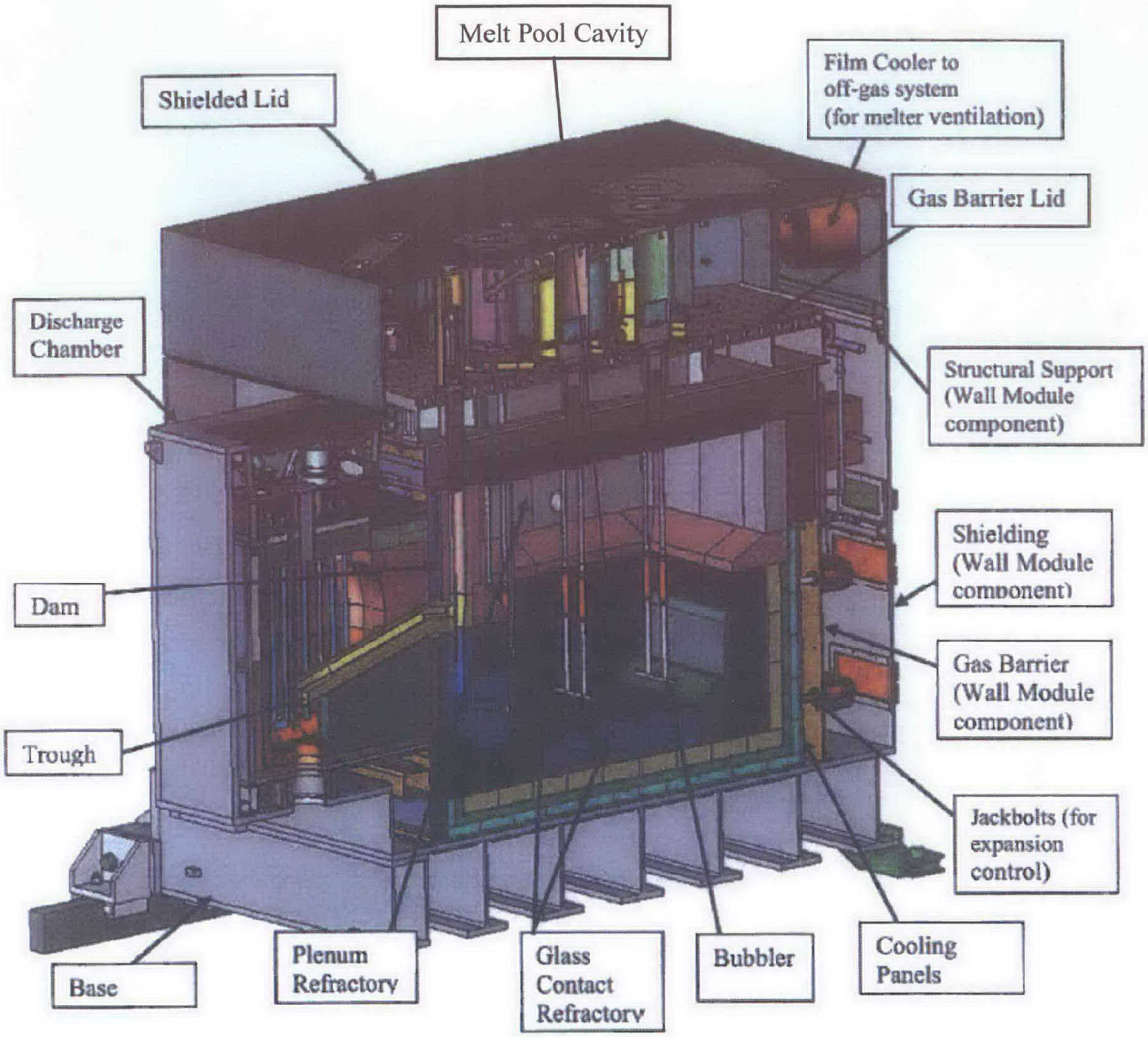


Figure 4-1 Low-Activity Waste Melter Section Through Riser with Major Components Identified

4.1.1.4 Main Cavity- Melt Pool Cavity

The refractory in the area of the melt pool is on a bed of Greencast 94 and is built up with two layers each of alumina zirconia silica (AZS) and then K3 brick. The walls are built out with the same two layers of K3 and AZS. At the exterior of the brick, cooling panels with a layer of mica paper for electrical isolation are positioned. The floor and three walls are built in this manner. The wall cooling panels are held in place by jackbolts that extend through the gas barrier and allow for thermal expansion of the refractory during heat up.

Six electrodes are positioned along the inside of the north and south walls of the main cavity. The electrodes are fabricated from Inconel 690 with extensions that allow for electrical connections to be made outside the gas barrier. The extensions are air-cooled and temperature is monitored. The electrodes are 3 in. thick by 20 in. high and rest in a notch cut into the K3 support block.

The south wall or hot wall that seperates the discharge chaimbers from the melt pool features the glass risers and discharge bulges. The hot wall is named such because it is heated from both sides, glass pool and discharge, which presents some unique challenges for the design of the refractory. The riser and air lift blocks are flanked by K3 brick backed by AZS brick to complete the wall. The E blocks and AZS are backed by castable refractory. The Inconel 690 trough accepts glass from the air lift and directs the glass to the container centerline. The troughs are seal welded to the dam to prevent glass migration behind the riser in this high temperature area, as depicted in Figure 4-2. The dam is a stamped Inconel 690 plate that extends to the cooler area of the south wall. The plate is stamped with indents to accommodate thermal stresses. The Kaolite and Versaflow castable compounds, backed by fiber board, form the heated discharge chamber and surround the trough and dam. Cooling panels remove heat around the dam to prevent glass migration at the edges of the dam.

Figure 4-2 Trough and Dam

The H block is set above the glass tank refractory and line the plenum walls. The H block can tolerate thermal transients from idle to operating conditions and the splashing glass and feed from the cold cap during processing. These blocks are backed by the Kaolite castable refractory, fiber board, and cooling panels.

The refractory package is designed to maintain 800 °C within the region of the glass contract refractory. Glass viscosity is high enough at 800 °C that no glass migration occurs at this temperature. Figure 4-3 shows the temperature and viscosity relationship within the refractory package. Cooling panels are used to drive the gradient.

The three electrode pairs are located in refractory pockets in the north and south walls. Electrode extensions pass through the nearest wall, for example, and the east electrode pair penetrates the east wall. In each case, the cooling panels in the area are positioned to prevent glass migration past the electrode extensions. Air cooling within the extension also helps contain the glass.

The south wall of melter is stationary, with the north, east and west walls allowed to move as thermal expansion occurs during heat up. The fiberboard in the discharge areas will crush to accommodate the small amount of thermal expansion in the discharge.

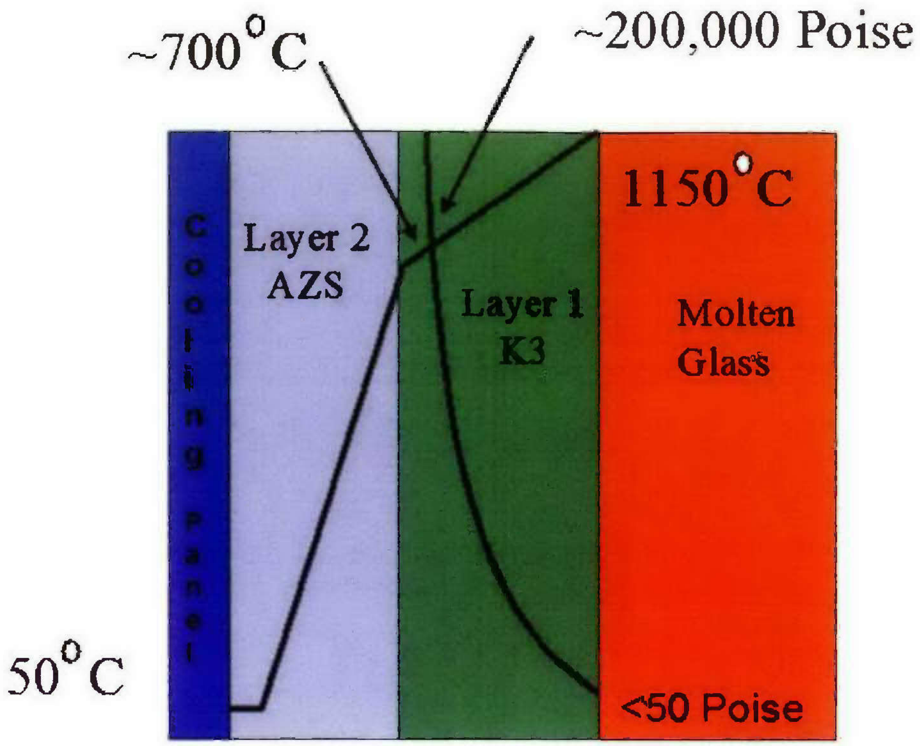


Figure 4-3 Illustration of Temperature and Viscosity Gradients

4.1.1.5 Gas Barrier Lid

The gas barrier lid provides the process containment and interface. The lid and all process connections are enclosed and contained by the shield lid, which is discussed as part of the structure. The design is shown in 24590-WTP-SDDR-ML-07-00117, 24590-WTP-SDDR-ML-09-00073, and others (see Table 4-1 for a list of supplier deviation disposition requests (SDDR)). The lower barrier plate is fabricated in three sections welded together to form a continuous gas barrier of 1 in. Inconel 690 plate. Protective refractory is hung below and a cooling channel is located above this plate. The barrier plate is susceptible to unacceptable stress if it is not cooled while the melter is at operating temperature. The cooling channel is enclosed by an upper plate and sides. Baffle plates within the cooling channel support the structure and direct the cooling water flow. The cooling channel is kept at atmospheric pressure, supplied by an independent cooling circuit. Cooling water returns to an open collection tank to avoid pressurizing the cooling channel. Cooling is described in Section 4.2.1.2.1 of this SDD.

The lid fabrication was completed by Peterson (24590-QL-YQA-MEEM-10135, Rev 000, *Low Active Waste Melter Fabrication and Assembly - Peterson Inc*) and (24590-QL-YQA-MEEM-10136, Rev 001, *Low Active Waste Melter Fabrication and Assembly - Peterson Inc.*).

Table 4-1 Table of Supplier Deviation Disposition Requests for Melter Lid, WTP-M-11806

Document Number	Rev	Title	Effective Date	File Type	Size (MB)
24590-WTP-SDDR-ML-07-00117	NA	WTP-M-11806, WTP-M-11811, WTP-M-11816: GAS BARRIER LID RE-DESIGN	09/27/2007	pdf	26.72
24590-WTP-SDDR-ML-08-00009	001	WTP-M-11806; LID FRAME ASSEMBLY DRAWINGS	06/19/2008	pdf	1.86
24590-WTP-SDDR-ML-08-00217	NA	6133-11806; LID FRAME ASSEMBLY	11/13/2008	pdf	22.72
24590-WTP-SDDR-ML-08-00329	NA	WTP-M-11806: COUNTERACT GAS BARRIER LID WELDING DISTORTION	12/11/2008	pdf	0.29
24590-WTP-SDDR-ML-09-00001	NA	WTP-M-11806: LID FRAME ASSEMBLY MODIFICATIONS / REVISIONS	03/02/2009	pdf	26.75
24590-WTP-SDDR-ML-09-00033	NA	WTP-M-11806, SHEET 1: EAST LID FRAME ASSEMBLY (NCR #B03118)	05/04/2009	pdf	1.59
24590-WTP-SDDR-ML-09-00035	NA	WTP-M-11806: LID FRAME ASSEMBLY MODIFICATIONS/REVISIONS	06/16/2009	pdf	32.43
24590-WTP-SDDR-ML-09-00045	NA	WTP-M-11806, SHEET 2: LID FRAME ASSEMBLY - GAS BARRIER LID # 1 (NCR #B03189)	06/23/2009	pdf	0.42
24590-WTP-SDDR-ML-09-00049	NA	6133-11806, SHEET 12: GAS BARRIER LID ASSEMBLY - OUT-OF-TOLERANCE (NCR B03208)	08/14/2009	pdf	0.85
24590-WTP-SDDR-ML-09-00051	NA	6133-11806, SHEET 6: GAS BARRIER LID ASSEMBLY - THREAD DEPTH (NCR #B03213)	08/14/2009	pdf	0.38
24590-WTP-SDDR-ML-09-00053	001	6133-11806: LID FRAME ASSEMBLY - INCORPORATE MODIFICATIONS TO DRAWING SHEETS 1-24	09/02/2009	pdf	2.31
24590-WTP-SDDR-ML-09-00059	NA	6133-11806: GAS BARRIER LID ASSEMBLY #2 (WELD DISTORTION AFFECTING PORT FLANGE THICKNESSES)	08/14/2009	pdf	0.51
24590-WTP-SDDR-ML-09-00065	NA	WTP-M-11806: LID FRAME ASSEMBLY - OUT-OF-TOLERANCE (NCR #B03350)	08/21/2009	pdf	0.43
24590-WTP-SDDR-ML-09-00067	NA	6133-11806: GAS BARRIER LID ASSEMBLY - OUT-OF-TOLERANCE (NCR #B03359)	09/10/2009	pdf	0.39
24590-WTP-SDDR-ML-09-00073	NA	6133-11806: GAS BARRIER LID FRAME ASSEMBLY (SHEETS 1-24, REV. 7)	10/27/2009	pdf	2.17
24590-WTP-SDDR-ML-09-00085	NA	6133-11806, SHEET 2: LID FRAME ASSEMBLY - OUT OF TOLERANCE (NCR #B03493)	12/24/2009	pdf	0.36

The lid upper plate provides the process interface for melter functions with penetrations through the lid. Each penetration is lined with Inconel 690 for corrosion resistance. The upper plate will accept various inserts for the penetrations and is machined at each port to provide the sealing surface for the inserts. The two offgas ports have flanges, which accept capture bolts in the mating film coolers.

Two layers of castable refractory are suspended from the bottom of the bottom Inconel 690 plate by both wire and block type anchors. The many penetrations in the lid continue through the refractory layers, formed during casting. The lower level of castable (Versaflow 57A) is exposed to the process and is more durable than the lower density refractory (Kaolite 2500-LI) near the metal lid. A layer of Duraboard HD at the Inconel plate provides a final insulating layer. See Figure 4-4 for a cross section through the barrier lid. The inserts, described in Section 4.1.1.3 of this SDD, each have a refractory plug to fill the penetration and complete the insulation. The inserts will include small slots to allow a small amount of in-leakage for cooling and to purge the penetrations of corrosive gases. Table 4-2 provides a listing of the functions of the various inserts in the lid penetrations, and Figure 4-5 provides a nozzle location map.

The melter lid redesign required a revision of the structural and thermal calculations. WTP provided the new analysis which is not in the set of Energy*Solutions* (ES) documents, but found in the SDDR for melter fabrication and project calculations. They are as follows: 24590-LAW-M2C-LMP-00001, *Thermal Analysis of Gas Barrier Lid*; 24590-LAW-M2C-M80T-00001, *LAW Melter Lid Stress Analysis / Summary*; and 24590-LAW-M2C-M80T-00003, *LAW Melter Lid Refractory Thermal/Structural Finite Element Analysis using ANSYS.*

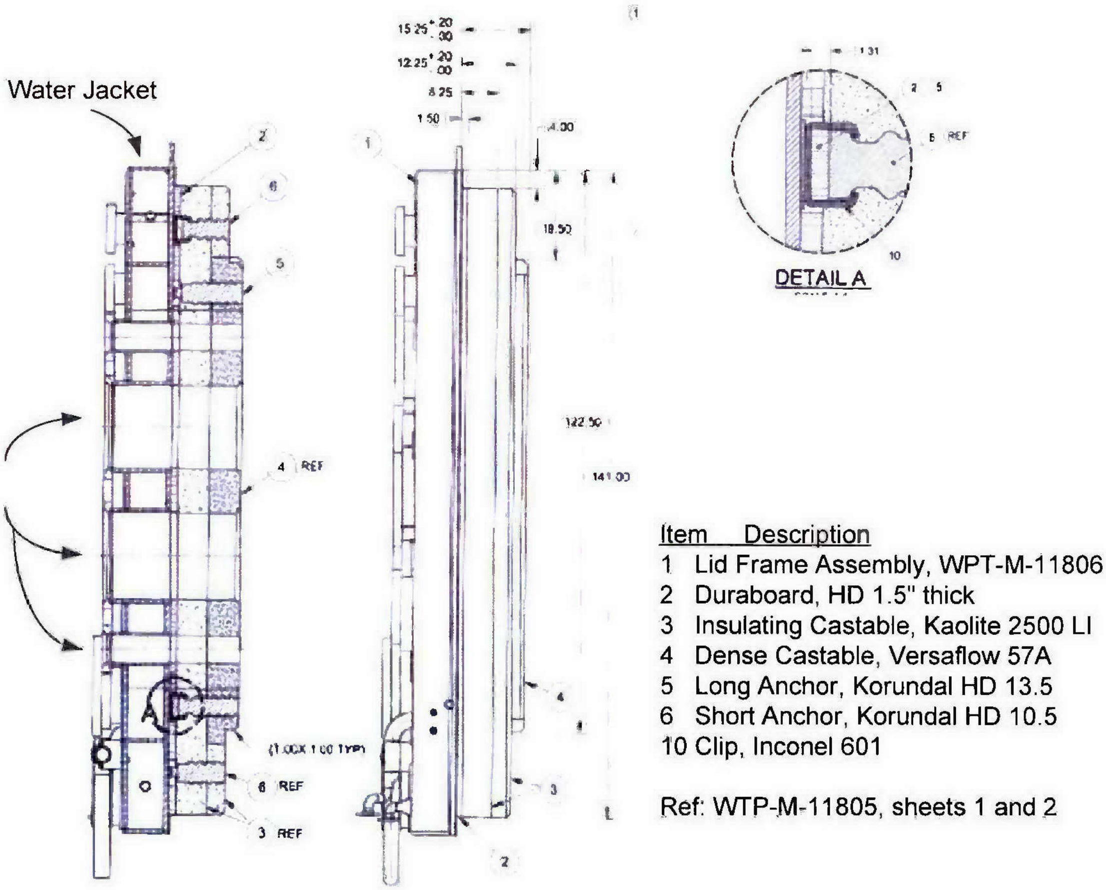


Figure 4-4 Lid Refractory Detail

Table 4-2 Lid Penetrations / Functions

Port ID	Description	Size	Assembly Dwg.#
WB 1 to 5 CB 6 to 13 EB 14 to 18	Bubblers with temperature	18.5 in.	WTP-M-12100 W11 -03-00468
	Startup heaters		WTP-M-12450-1 W11-03-00469
EO 2	Primary offgas film cooler	14.5 in.	WTP-M-12650 W10 -409-779

Port ID	Description	Size	Assembly Dwg.#
WO 1	Standby offgas film cooler	14.5 in.	WTP-M-12630 W10 -409-763
WA 1 EA 1	Air lift lance	6 in.	WTP-M-12300 W10 - 409-080
WF 1, 2 CF 3, 4 EF 5 , 6	Feed nozzles	6 in.	WTP-M-12200 W10 - 409-059
CT 1	Refractory temperature	6 in.	WTP-M-12170 W10 - 409-055
WL 1 ES 8 (spare)	Level detector	6 in.	WTP-M-12250 W10 -409-069
WO 3 EO 4	Discharge vent - west discharge vent - east	6 in.	WTP-M-12800-7* W10 -409-823 WTP-M-12800-8*
WS2, ES9	Frit addition (spare)	6 in.	WTP-M-12600-1 W11-03-00482
WS-1 CS-3, 4, 5, 6 ES- 7	Spares / small plug	6 in.	WTP-M-12920 W11-03-00475
	Medium plug	14.5 in.	WTP-M-12910 W11-03-00474
	Large plug	18.5 in.	WTP-M-12900 W10-409-834
# Drawing prefix abbreviations W10 = 24590-101-TSA-W000-0010; W11 = 24590-QL-HC4-W000-00011. *See 24590-LAW-VDCN-ML-06-00104, 24590-LAW-VDCN-ML-06-00105, and 24590-LAW-VDCN-ML-06-00107.			

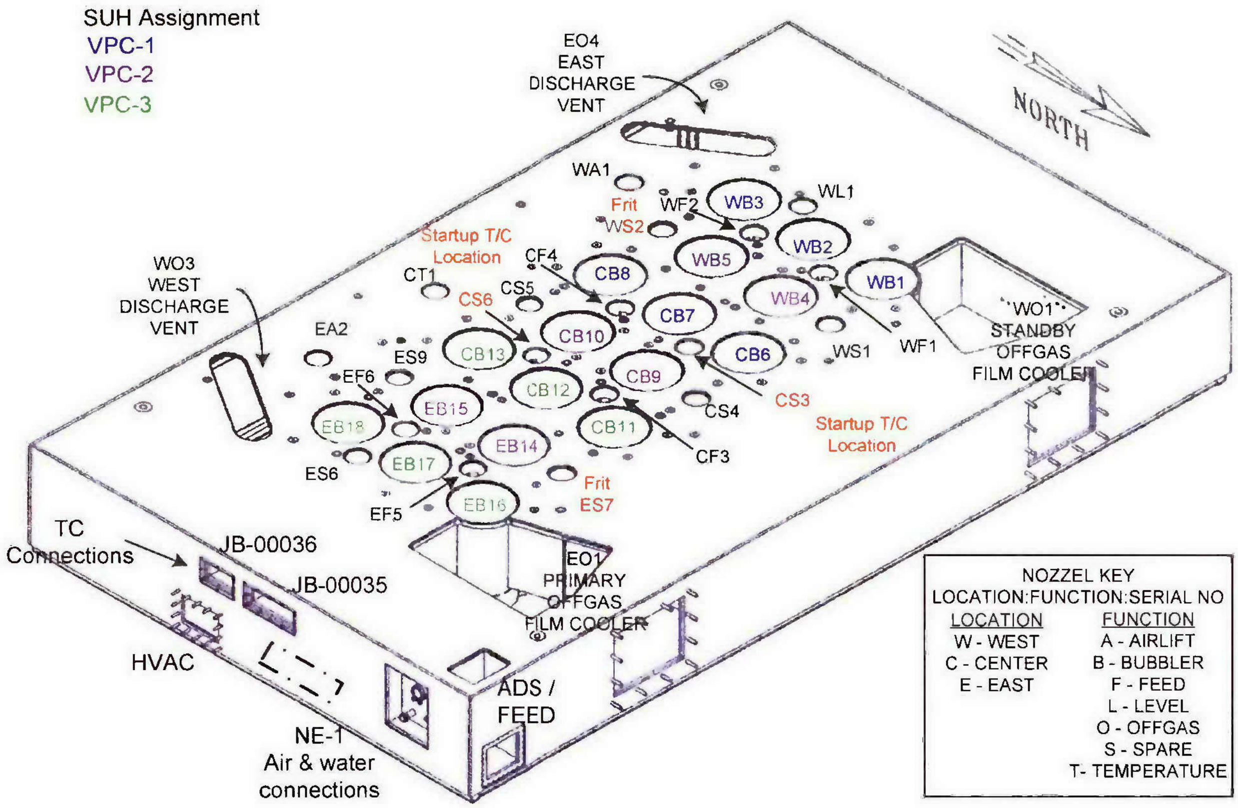


Figure 4-5 Lid Nozzle Functions – Including Startup Equipment

4.1.1.6 Melter Structure / Shielding

The gas barrier and refractory are supported by a support structure, which was fabricated as base and wall modules. Tubular steel forms the frame and two support bands that encircle the gas barrier and provide the attachment points for the jackbolts. The inside plate of the base unit and the four wall modules form the cavity gas barrier when welded together. The wall modules set on the base, and the shield lid fits on top, over the gas barrier lid, resting on the wall module structure. The discharge chamber is also supported by this structure. Figure 4-6 is a photo of the melter inside structure and annulus, showing the shield plates, box beam support structure, gas containment, and internal utility piping. The gas barrier lid is placed on top (not shown in picture).

The base unit is designed as a rigid platform to hold a total melter weight of 350 tons. The base will set on rails spanning a distance of 28 ft – 4 in. Six wheels on each rail will allow the melter to be moved in and out of the melter cave. The top plate of the base must be very flat with a maximum of ¼ in. deflection under full load across the entire plate. Flatness required for proper refractory performance. A thin layer of mica is bonded to the plate for electrical isolation of the base. Cooling panels are attached to the bottom of the plate, between support beams. The base also provides the attachment points for seismic restraints.

Shield plate covers the entire melter and offers an additional barrier to contain gases, contamination and radiation. Although removable panels provide access to melter components, the panels have a lap joint to the main body and gaskets to maintain a seal. The access panels are equipped with bails to facilitate lifting. Shielding on all six surfaces of the melter is provided as follows:

- Base plate includes 1.75 in. of shielding
- Walls include a 1 in. plate
- Lid includes 1 in. plate with 2 in. plate over the offgas ducts
- Discharge chamber is covered by 2 in. plate

The support structure will house all of the services for the melter. All fluid services pass through bulkhead connections in service panels, grouped by service or utility. For example, all melter feed connections pass through on bulkhead panel from each ADS pump. Hoses inside the shield lid carry feed to the individual feeds nozzles. The melter electrode bus connector will be mounted to the base and the electrode buses will pass through it. These services will be electrically isolated from the structure. The gas barrier and shielding drains also pass through the structure. Similarly, all of the lid instrumentation signals are routed through the structure with connection panels mounted on the shield panels for completing the various connections.

A summary of the interior and exterior dimensions of the melter structure and refractory is given in Table 4-3. The pool and plenum columns provide the total cavity size. These are initial dimensions, and it is expected that the Monofrax K-3 glass contact refractory could lose up to 1 in. per year from erosion and corrosion.

Figure 4-6 Melter Structure and Annulus

4.1.1.7 Design Features of Cooling Panels

Cooling panels surrounding the glass tank limit the extent of glass leakage and migration by cooling the refractories and causing glass to "freeze." The glass melt viscosity increases sharply as the temperature drops. Cooling of the exterior walls of the glass contact refractory package therefore reduces the rate of corrosion of the interior refractory by the glass melt.

Cooling panels are located on the north, east, south and west melt pool walls; the north, east and west plenum walls; the melter base; the discharge chamber walls and bottom; the gas barrier lid; the bottom surface of the top shielded lid above the offgas film coolers (shielded lid cooling); and the melter lid cavity. The six feed nozzles also have additional cooling circuits. The gas barrier lid cooling panels are designed to be emptied at melter changeout or decommissioning.

The melter designers considered the possibility that water could leak from cooling panels. Such a leak inside the melter poses risks of over-pressurization due to steam generation. To mitigate this risk, the melter is designed with no sealed cavities between the cooling panels and the melter refractory, and it is equipped with drains and level detectors on both the inside and outside of the gas barrier to prevent water accumulation. In addition, the water drains to an RLD sump and the drain lines are sloped towards the sump and contain locked-open ball valves to ensure proper draining. Also, the water return lines have flow meters that alarm on low flow. These flow meters also allow operators to ensure proper service to the melter before startup. The compartment between the gas barrier and the melter refractory has engineered in-leaks to keep this zone purged of corrosive gases. This feature also prevents pressurization inside the gas barrier that could cause structural damage and/or force water through the refractory into the melt cavity. There is insufficient heat in the cooling panel zone to cause steam explosion due to the isolation of this area from the melt cavity by the refractory layering. The cooling panel has increased material thickness on the inboard side to further reduce risk of water contact to brick (i.e., any failure will be on outboard side, away from the brick face). Cooling panels are ASME *Boiler and Pressure Vessel Code* Section VIII vessels. Those exposed to corrosive gases (inside gas barrier against refractory) are fabricated from alloy C-276 for corrosion prevention.

Table 4-3 Melter Dimensions

	Melter Enclosure	Refractory Envelope	Internal Cavity	
			Pool (melt line)	Plenum
East - West	30 ft – 7 in. rails 28 ft – 4 in.	20 ft	16 ft – 2 in.	17 ft – 10 in.
North - South	21 ft – 10 in. *	10 ft – 6 in. (pool)	6 ft – 8 in.	8 ft – 4 in.
Height	15 ft – 10 in.	9 ft – 5 in. #	2 ft – 6 in.	3 ft – 3 in.
* Includes discharge chambers. # Includes lid refractory. ^ New melter, no material loss.			Glass pool is approximately7000 liters (248 ft^3. or 36,780 lb glass at 2.4 SpGr.	

4.1.1.8 Discharge Section

Each melter has two discharge sections. A single discharge could provide the desired pour rate capacity. The two discharged are planned to be used for alternating fill cycles; i.e., fill a container at the east discharge, then use the west discharge. The components required to transfer glass from the melter into a container include the following: melter components - melter glass level bubbler, glass riser, and air lift lance; discharge chamber components - trough, discharge chamber heaters including thermocouples, and ventilation; the pour spout assembly - pour spout, seal head, glass pour viewing, the container glass level (IR) detector, and gamma level detector; and finally, the container supported by the turntable and elevator. Details of some of these elements are discussed elsewhere in this document and will be only covered briefly here. There are two set of these components for each melter. Figure 4.7 provides a section view with many of these items shown.

Slurry feed to the melter results in a cold cap that fuses into the melt pool. As glass is produced, the pool level increases, which is tracked by the melter glass level detector. Glass is periodically drawn off into a container by air lift to maintain pool level within a range. Batch pouring is required so that glass will flow to the periphery of the container. It is desirable to limit the level change in the pool as it seems to disturb melter operation, with glass temperature changes and associated cold cap response. A melter level operating range of 30 ± 1.5 in. is recommended by ES. Four air lifts with an approximate 2 in. level change in the melter will fill a container, taking about 9.6 hours at 15 MTG/d. One container will be filled, and then the second pour spout will be used to fill the second container.

4.1.1.9 Discharge Lid

The discharge area is a heated extension hanging off the end of the melter that houses the trough. It provides a controlled, heated space that allows the glass to pour into a container, as described in the air lift section. The discharge is vented to the main cavity through a jumper exterior to the melter. The jumper includes an orifice to limit the airflow to the main cavity. A description of the refractory package is found in the containment section and the heater bars are described in the heating section.

A discharge lid with silicon carbide heater bars is positioned over the discharge cavity to keep the chamber and the glass hot. The glass is kept hot to facilitate pouring and to assure the glass will flow to the edges of the 4 ft diameter container.

The heater bars can be replaced as a unit with the discharge lid. To maintain the longevity of the heaters, temperature changes should be kept to a minimum. As the heaters are used, a layer of silicon is built up on the exterior of the bars. As the layer thickens, the resistance of the bar increases. The bar becomes more fragile and eventually heat output is limited. Each U-bar is wired out to the control area and controlled and monitored separately. Even usage and minimizing thermal cycles will limit the growth of the silicon layer on the bars. Care of these heaters can extend heater life two to three times, which potentially can allow heater lid changeout to coincide with the 5 year melter changeout cycle.

The discharge cavity is vented to the main cavity through jumpers connecting the two discharge lids to the melter plenum (LMP-SPOOL-00001 and LMP-SPOOL-00002, melter 1; LMP-SPOOL-00003 and LMP-SPOOL-00004, melter 2). They are mirror images of one another, located in the lid annulus (24590-LAW-VDCN-ML-06-00105, *WTP-M-12800, Sheet 1, Rev. 1: Add Line Items*). There is a ¾ in. orifice in each jumper to limit airflow.

There is an auxiliary heater positioned around the pour tube at the bottom of the discharge section. The heater can be used to melt and clear glass that has accumulated in this area. The heater would have to be connected to a temporary power supply for use.

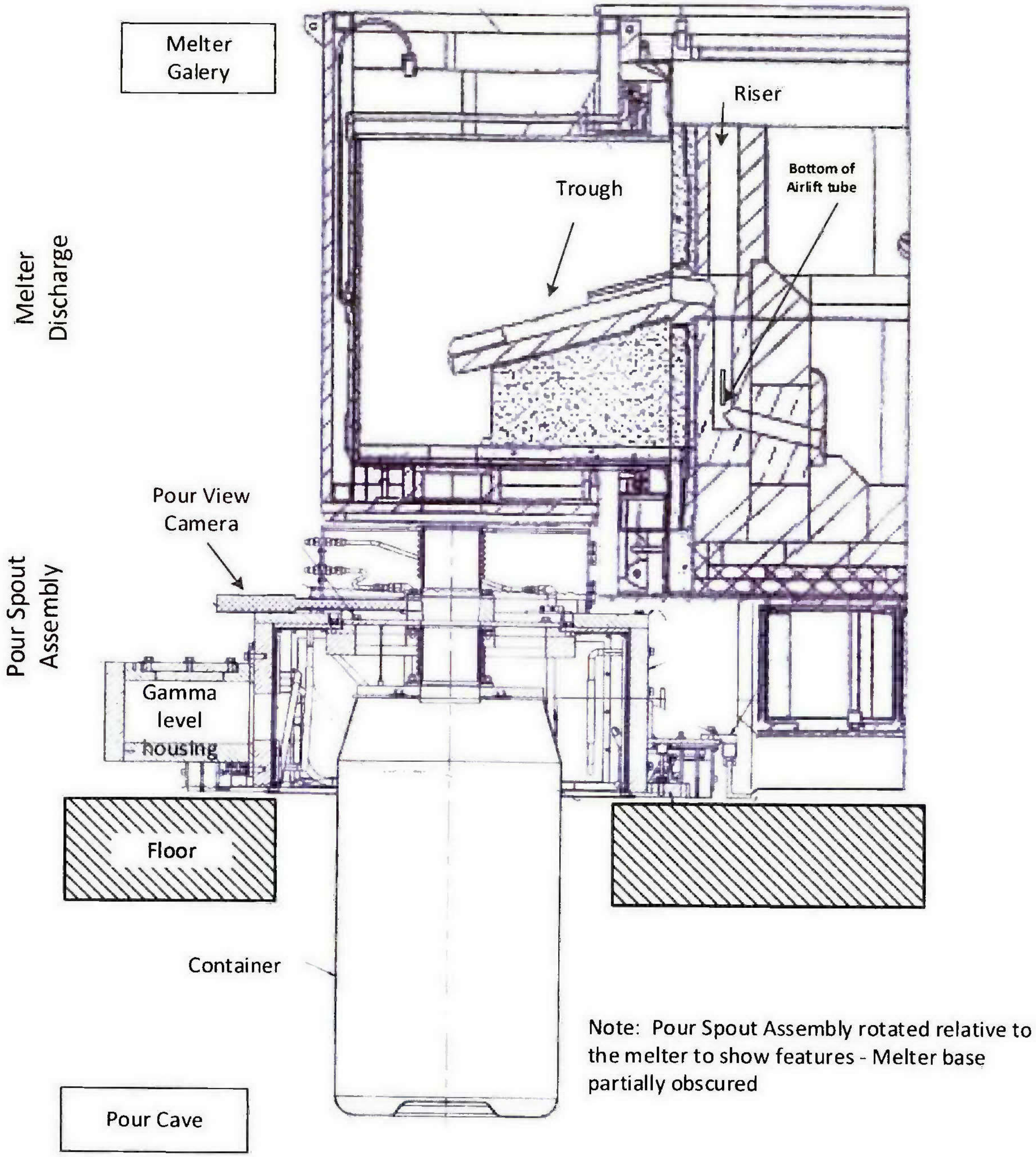


Figure 4-7 Discharge Cross Section

4.1.1.10 Pour Spout

The pour spout assembly fits between the bottom discharge flange and the melter chamber floor. The pour spout is a transition piece, conducting the glass stream from the discharge, through the melter gallery floor to a container in the pour cave. The LAW melter pour spout assembly serves the following functions:

- Provide the interface between the melter discharge chamber and the waste container.

- Provide the interface between the melter discharge chamber and the melter pour cave.
- Prevent the introduction of foreign materials into the waste container.
- Prevent damage to the lidding area of the LAW container.
- Provide the mounting location for the pour view camera.
- Provide the mounting location for the container view camera.
- Provide the mounting location for a gamma level detector. (Detector removed from design.)
- Provide the mounting location for the infrared level detection camera.
- Provide shielding between the pour cave area (R5) and the melter gallery (R3) to maintain the dose limits to 2.5 mrem/hr, at 12 in. from any surface of the pour spout assembly.
- Provide a contamination boundary between the C5 pour cave ventilation system and the C3 melter gallery ventilation system.
- Provide a means for removal and replacement of the pour spout assembly.
- Provide a floor seal plate cover that can be rolled into place to cover the floor opening when the pour spout assembly is removed.

The pour spout assembly consists of the pour spout, seal-head, floor seal plate cover assembly, seal-head rail and seismic anchor, air knife assemblies, pour view camera, container view camera, gamma level detector, and IR level detection camera. The pour spout assembly is installed by rolling it under the melter using a temporary track to guide it in place.

The seal head houses the pour spout and provides shielding and cooling to protect from a hot container. It also accommodates the pour view camera, the container view camera, the IR level detector, and the gamma level monitor. Flexible bellows are used to provide a 13 in. diameter pathway from the discharge to the container.

The upper bellows accommodate for potential minor misalignments between the melter and the pour spout assembly. It will also compensate for thermal expansion of the pour spout without placing excessive loads on the seal-head or melter. The upper bellows is a commercially available 13-in. diameter bellows fabricated from alloy 625 (Inconel 625). Alloy 625 is used for its excellent long-term resistance to corrosion as well as its high temperature strength. The bellows has a single liner welded to the bellows tube near the top flange. The lap-joint type top flange is used to facilitate aligning it to the melter discharge chamber flange. The bellows also include external turnbuckles to compress the bellows to provide the needed clearance during installation and removal and to assist in pulling the flange away from the discharge chamber, if it sticks. The upper bellows is sealed to the melter and mounting flange with graphite sheet gaskets.

The container seal ring is the physical interface with the container. It is fabricated from a 40 in. diameter 2-in. thick disk of alloy C-276 (Hastelloy) plate. This disk weight is approximately 690 lb and provides the weight needed to extend the lower bellows when lowering the container. Support cables are attached between the container seal ring and the pour spout mounting-flange to prevent overextending the lower bellows. The bottom surface of the seal ring has a double-bulb ceramic fiber tadpole gasket (i.e., Nextel jacket with ceramic rope core) installed within a machined groove. This gasket limits the air in-leakage at the container to pour spout interface. The pour spout mounting-flange is the attachment point for the upper and lower bellows, the insertion point for the pour view camera, and the support for the entire pour spout. The pour view camera insertion point is provided with a single-bulb ceramic fiber tadpole gasket to limit the air in-leakage around the camera. The mount flange has been provided with an additional outer mounting ring that will normally allow the pour spout to be lifted from the pour spout assembly but also allows it to be lowered into the pour cave with the container in the event of a container over-filling event. The mounting flange uses a graphite sheet gasket to form a seal with the outer mounting ring and a fiber gasket (John Crane company style 4160) to seal the outer mounting ring to the seal-head.

The bellows assembly is expected to be changed out with the melter. The calculated life of the upper bellows is 3793 thermal cycles (24590-WTP-TQ-G-03-066, *Technical Query*).

The lower bellows accommodates for potential horizontal misalignment of up to 1 in. between the melter and the container as well as to account for up to 3 in. of compression due to thermal expansion of the container during filling. The lower bellows is also a commercially available l3-in. diameter bellows fabricated from alloy 625 with a single liner welded to the top of the bellows tube. The lower bellows is sealed to the mounting flange and seal ring with graphite sheet gaskets.

4.1.1.11 Container

The ILAW container is a right circular cylinder 7 ft 6 in. high and 48 in. in diameter, fabricated from dual certified type 304/304 L stainless steel. The bottom is a reversed dish head. The container is necked to 30 in. in diameter at the top and fitted with a 1.5 in. thick, 36 in. diameter flat top plate. The excess diameter of the top plate forms the lifting surface for the container grapple. The diameter of the opening is 13.5 in.

The container details are provided in 24590-LAW-3ZD-LRH-00001, *LAW Container Receipt Handling (LRH) System Design Description*. To fill a container with glass, it is placed in the turntable, indexed under the pour spout, lifted by an elevator, and pressed against the pour spout lower bellows to seal the container to the melter.

A container filled to 95 % volume will weigh approximately 5900 kg or 13000 lb assuming a glass specific gravity of 2.6. Normally, an alternating pour sequence will be used, where a container is filled at one discharge or turntable location and the next container is filled at the other location. The container is moved to the turntable import and export position and changed with an empty container. The full container is moved through the transfer tunnel to the buffer storage area, where it is stored or lifted to container finishing.

4.1.1.12 Inserts

Support hardware for the melter is provided by removable inserts, which fit into the melter lid.

The melter lid is designed with penetrations that will accept inserts with the process provisions to control the melter. These inserts have a limited life given the process conditions experienced by this equipment. Metallic parts that are in contact with the molten glass are especially prone to corrosion and failure. Corrosion at the glass surface is most severe. These parts, like bubblers and level probes will be replaced on a regular basis to preclude loss of pieces into the pool. Figure 4-8 shows various melter inserts. The startup heater is the only insert with a simple bail and not equipped with the ball lift connector that interfaces with the consumable change-out box (CCB).

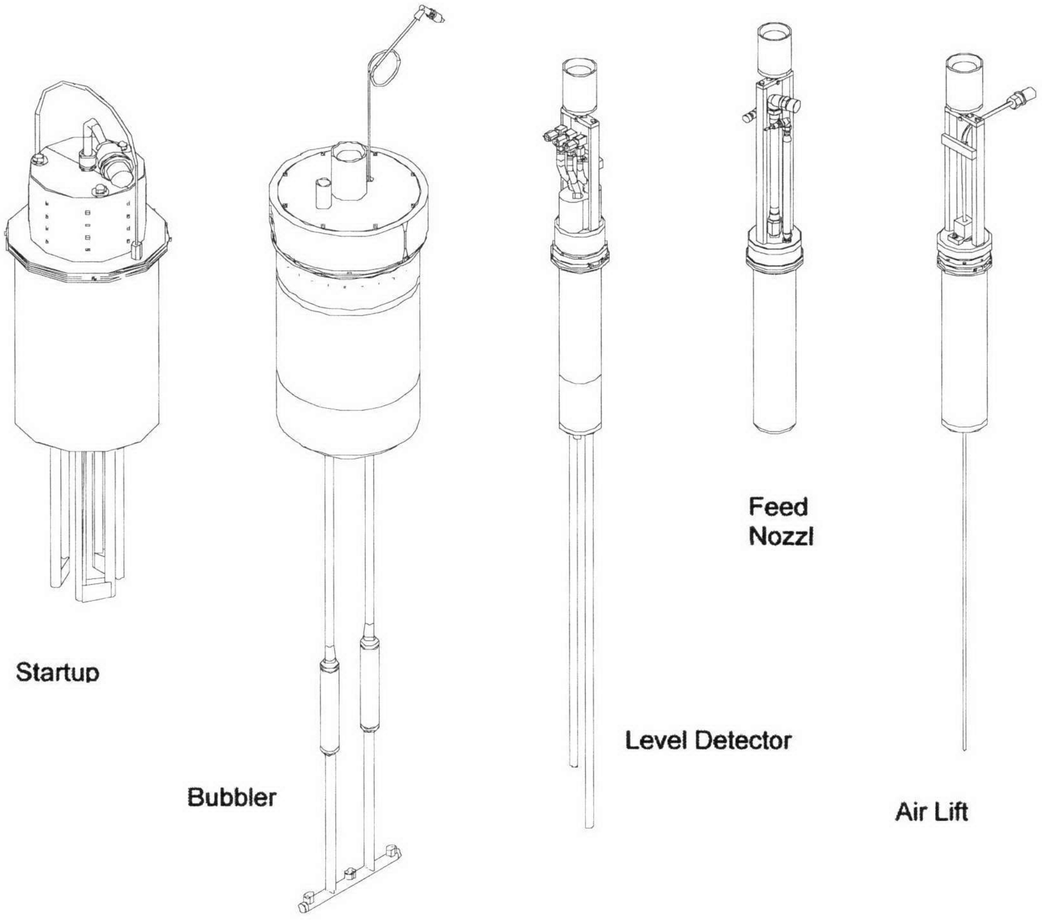


Figure 4-8 Melter Inserts

4.1.1.13 Consumable Changeout Box

The CCB is used to mitigate the effects of breaching the melter gas barrier and shield box C5V ventilation barrier during replacement of consumables in the melter. The CCB is used with a "gamma gate" that provides a closure at the shield barrier when the CCB is not present. The CCBs are part of the LSH system.

The CCB will contain contamination and glass shards that come off glass coated consumables. The CCBs for new equipment will be segregated from the CCBs used to remove spent consumables.

4.1.1.14 Startup Heater

Startup heaters are installed in the bubbler ports when the melter is cold and empty to initiate the dry out process and the rise to operating temperatures. Silicon carbide "U-bar" heaters are wired for three phase power. The startup heaters are the only melter inserts that do not interface with the ball lift connector and the CCB. The heaters are lifted directly by the melter service crane. Electrical connections from the heaters are made via high temperature cable and power connectors. Special shield covers are used that allow the heater cable to pass through the melter enclosure, but maintain normal ventilation control. Extension cabling will be provided to reach receptacles on the gallery south wall at rack LVE-RK-20101. See drawing 24590-LAW-E1-LVE-00029, *LAW Vitrification Building Melter 1 & 2 Start-Up Heaters Single Line Diagram*, for single line diagrams.

4.1.1.15 Feed Nozzles

Each melter has six water cooled feed nozzles installed. These inserts have cooling, which protect the feed from drying out and plugging the feed nozzle. The feed nozzles are each supplied by a dedicated ADS feed pump in the melter feed tank (LFP system).

4.1.1.16 Level Assembly

Each melter has a level measurement assembly consisting of three pneumatic probes or pneumercators. Because two of the measurement probes extend into the glass, they will be at the glass potential. To protect operators and equipment, the upper portion of the level assembly is electrically isolated from the tubes. The pneumatic connections are made through Teflon tubing. Level assemblies are installed and removed with the CCB as described with the bubblers.

4.1.1.17 LAW Bubblers

Description

The bubblers provide agitation for the glass tank that accelerated processing of waste into glass. The assembly is shown in Figure 4-9 with major features labeled. Air is used as the bubbling medium. The bubbler nozzles will not clear if glass backs up into the bubbler. Therefore, a compressed air supply is included in the assembly for melter insertion. The LAW melter is provided with 18 bubbler assemblies for uniform agitation across the glass pool. Each bubbler assembly also comes with an integral thermowell, which houses a three-element probe. A thermocouple is placed deep in the glass pool (3 in.), midway in the pool (20 in.), and in the plenum (60 in.), or air space above the pool.

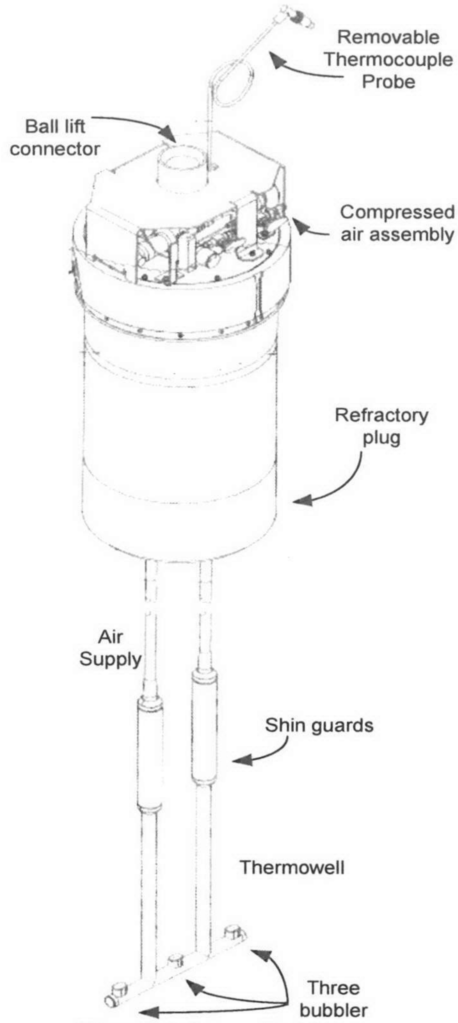


Figure 4-9 Bubbler

Bubbler air connections are made from the cave wall to connection panel on the west side of the shield lid. From panel, conduit with hose is run to each melter nozzle inside the shield lid, where the final connection is made to the bubbler assembly. Similarly, the multi-element thermocouple probes are connected by cables coming from the east and west walls to junction boxes on the shielded lid. The west side junction boxes are LMP-JB-0033 and LMP-JB-0034 [LMP-JB-0053 and LMP-JB-0054] and east junction boxes are LMP-JB-0035, and LMP-JB-0036 [LMP-JB-0055 and LMP-JB-0056]. Extension cable leads from the junction boxes to each nozzle. Multi-pin connectors are used to connect all elements at once.

Air to the bubbler assemblies is individually controlled. The nominal flow rate is 0.75 scfm to each bubbler assembly controlled through the PCJ.

Bubblers will be installed after melter bake out, frit addition, and initiation of joule heating. Startup heaters are removed one at a time and replaced by bubblers. Startup heaters are handled by the process crane. Bubblers are handled with the CCB as described in the LSH and LAW melter support handling system description. During normal operation, the bubblers are spent after 6 months and are replaced with new bubbler assemblies. The CCB uses a ball-lock lift interface to engage bubbler assemblies and other melter components. When a bubbler assembly, weighing approximately 585 lb, is moved without the CCB, the lifting lug assembly and a ball-lock lifting apparatus (Carr Lane Mfg. # CL-16-LFP-1.00) will be needed as the lifting interface with plant cranes.

Prior to the import sequence, the bubbler air tanks must be pressurized to approximately 3500 psig with air, and the thermocouple probe must be installed. The purge air is regulated by a flow meter and two single stage pressure regulators, in addition to two pressure relief valves to protect the system. System pressure regulators are set to 80 psig and 14 psig, with the flow meter at 6 scfh. The air tanks provide a minimum of 1 hour supply of air at 0.1 scfm to the bubblers to prevent glass backup. In testing, the air supply could last at least 2 hours. This air purge must be turned on while the bubbler assembly is in CCB during installation. There are ports in the CCB for access.

The bubbler assembly must be oriented in the import station so that an alignment bar fits into a groove in the assembly. The alignment is carried through the CCB so that the bubbler is properly positioned in the melter.

The primary purpose of the CCB is to contain glass and gases coming from the melter and the glass coated components during changeout of spent units. As bubbler assemblies, level probes, and air lifts cool after removal from the melter, adhering glass will spall off and scatter. The CCB collects this material. The CCBs are divided into "clean" boxes for new items and contaminated boxes for removal of spent components. A storage area is designated for CCBs in the melter gallery.

Once the bubbler assembly is positioned in the melter, the CCB and gamma gate are removed. The air supply is connected by a pitless fitting, which has a spring loaded pressure plate for sealing. Air is automatically engaged as the bubbler assembly is lowered in place. The multi-point thermocouple connection is made manually within the shield lid, and the cover plate placed in position. Access to these connectors has not been evaluated in terms of the local temperature and radiation. Available extension wire is included to pull them up to the shield lid for connection and replacement within the lid.

Bubbler assembly life is estimated at 6 months, based on LAW pilot melter testing. The mode of failure is corrosion of the legs that extend into the glass pool. The area at the glass air interface is where the most aggressive corrosion occurs. Shin guards have been added to the legs in this region to extend life. In addition, Inconel MA 758 has been found to be the most resistant material for the legs. (MA 758 has a composition similar to Inconel 690, but it is formed through a powdered metallurgy process that provides a different grain structure and better corrosion resistance.)

Instrumentation and Control

Nominal bubbler airflow is 0.75 scfm per assembly. This flow was used almost exclusively during pilot testing. During pilot testing, adjustments in airflow down to 0.25 scfm reduced the processing rate by 20 %. Equivalent bubbler airflow as high as 1.2 scfm have been tested at other scales. In addition, skewing—i.e., bubbler to bubbler variation of flow—has been used to mitigate uneven accumulation in the cold cap. There is very little data at airflows higher than 0.7 scfm.

Each bubbler has separate flow and temperature instruments for monitoring. The bubbler positions are numbered north to south and west to east, so that the first bubbler, WB1, is at the northwest corner of the melter. The thermocouple connection junction boxes are at the east and west sides of the shield lid. These thermocouples are averaged for use as control feedback for melter power.

4.1.1.18 Air lift

The air lift is a tube positioned in the glass pour riser. Airflow through the tube changes the buoyancy of the glass in the riser relative to the glass pool. This effectively pushes glass over the trough through the discharge chamber and into a container below. Figure 4-7 shows the final positioning of the air lift tube, as modified by 24590-WTP-SDDR-ML-08-00317, *WTP-M-12300 Sheet 1: Air Lift Lance Assembly (NCR# B02970)*. Air lift submergence is the ratio of the length of tube submerged in the glass over the total lift height. Submergences of 60 % - 70 % are desired. The SDDR increases the air lift tube length to attain the desired submergence. The tube is Pt- 10 % Rh.

4.1.1.19 Plugs

All unused penetrations in the melter lid are filled with plugs. The plugs are blocks of refractory sized to fill the penetration. Sealing at the gas barrier lid is provided as well as air bleed holes to keep the penetration free of deposits. The plug has a more durable refractory at the bottom (plenum end) and a refractory that is a better insulator above. The plugs are all fitted with the ball lock lift device.

The lid has been designed with three sizes of penetrations; the smallest is a 6 in. diameter hole, medium is a 12 in. diameter, and the largest is an 18 in. diameter. Plugs are available in all three sizes.

4.1.2 Boundaries and Interfaces

Interface locations and descriptions will be provided in this section.

4.1.2.1 Ventilation and Offgas

4.1.2.2 Ventilation

The melter sets in the melter gallery, which is ventilated by the C3V system, and has the potential to be contaminated, occupied room. The C3 area ventilation is cascaded into the C5V airflow. Inside the melter shielding, the melter annulus is ventilated by the C5V system, which supplies air to the melter shield lid from the wet process cell. The interface is located at the duct connection to the lid. Air is also exhausted from the lid to the C5V treatment, and a duct extends from the lid into C5V. Manual dampers are adjusted to balance flow. A total of 1300 scfm of air is supplied, approximately 300 scfm is pulled into the melter, with the rest exhausted from the lid into the main C5V duct to the high efficiency particulate air (HEPA) filters mixing with approximately 50,000 cfm of air.

Glass is poured into a container in the pour cave, which is a C5 area. Each pour spout provides part of the barrier between the C3 gallery, the melter, and the pour caves.

4.1.2.3 Melter Offgas

Gases are generated in the melter, including steam, NOx, CO_2, and CO. The melter has air in-bleed provisions to purge corrosive vapors away from the two glass discharge ports and various metal components. The combination of LOP and LVP provide the constant ventilation to maintain approximately a 5 inWC negative pressure relative to the melter annulus. A main ventilation line and a backup line to the SBS are provided. Each line ends with a film cooler, located in the melter lid. Plant service air is supplied to the film coolers though connections in the shield lid.

The offgas systems has interlocks to interrupt the melter feed, thereby reducing the hazardous gas generation at the melter; these are high pressure (low vacuum) and a loss of operability of any of the unit operations.

4.1.2.4 Feed Preparation and Delivery

Feed directly determines the temperatures and pressures within the melter. The feed also directly determines the properties of the glass produced by the melter.. Feed preparation in the LFP system is controlled to achieve the proper formulation for continued melter operation. When a feed batch is completed, it is sent to the melter feed vessel, where up to six ADS pumps move that feed to individual feed nozzles in the melter lid. The interface location is at the connection of the feed lines to the leak detection box enclosure at the melter gallery/wet process cell wall. The enclosure around the feed lines is provided to detect and capture potential leaks or spills from the feed lines. The enclosure is drained to RLD.

4.1.2.5 Cooling Water

Melter cooling water is supplied by dedicated and redundant LAW PCW heat exchangers and pumps. The ultimate heat sink is the air cooled tower in the BOF. The cooling tower provides water in the range of 57 to 77 °F (winter to summer), which results in water at the melter equipment at 65 -84 °F. This range is desirable so that atmospheric condensation is avoided. Melter 1 is serviced by heat exchanger PCW-HX-00004 A/B and pump PCW-PMP-00010 A/B; and melter 2 is serviced by PCW-HX-00005 A/B and PCW-PMP-00011 A/B. The heat exchanges are cooled in turn by the BOF PCW cooling tower. This equipment is located at elevation 28 ft room L-0224. The interface is at supply valves PCW-V-12617 for melter 1 and PCW-V- 12619 for melter 2; and return valves PCW-V-12618 and PCW-V-12620.

Melter lid cooling is a separate loop, but still supplied by PCW. Both cooling and treated water is supplied by each melter loop to the lid cooling loop.

Cooling is also supplied to each melter power supply. As above, heat exchanger PCW-HX-00007 A/B and pumps PCW-PMP-00013 A/B service both melter 1 and melter 2 power supplies. Water for this cooling loop is supplied from DIW. See Section 4.1.2.5.2 of this SDD, water quality for requirements.

4.1.2.6 Air and Gases

4.1.2.6.1 Plant Service Air

Plant service air is compressed dry air suitable for use in the plant. Air users include the container cooling air knives and the Instrument air system. Interface at valve LMP-V-31666.

4.1.2.6.2 Instrument Air

Clean, dry compressed air from the PSA system is further filtered and hydrocarbon residual removed for use as instrument air. It is used for the melter glass bubblers and for electrode cooling. Instrument air is also the purge air for pressure sensing lines and pneumatic valve operators. The interface occurs downstream of the coalescing filters, ISA-FILT-00002A/B, at valve LMP-V-32118, located at elevation 28 ft, room L-0220.

4.1.2.6.3 Argon

Argon gas is supplied to LMP from the MXG system, which stores bulk liquid argon for distribution. Argon is used to reduce the oxidizing potential of air injected into the molten glass. The in-glass level probes and the air lift purge both use argon. Normal operation of the air lift uses ISA, with a constant purge of argon. The interface occurs at valve LMP-V-31657, located at elevation 22 ft, north of melter 1. The argon skid is located at the elevation 3 ft in room L-0137.

4.1.2.7 Power

4.1.2.8 Melter Electrode Power

Electrical power to the melter main electrodes is supplied directly by system MVE to power supplies MVE-PSUP-20001 and MVE-PSUP-20002 from 13.8 kV switchgear MVE-SWGR-20603 (A bus) and MVE-SWGR-20604 (B bus). Each power supply is fed from both buses with a manual crosstie switch. The power supplies are located at elevation -21 ft rooms L-B002 and L-B004. Each melter has two 50 % trains of power supply; either train can support an idle melter.

There is a second interface as the power supply output to the melter is delivered to low voltage power bus that can transfer approximately 10,000 amps to the electrodes. The buses are designated LVE-BUS-20000 and LVE-BUS-20100 for melter 1 and LVE-BUS-20001 and 20101 for melter 2. These buses are not connected to any LVE equipment.

4.1.2.9 Melter Power Supply Cooling

The two melter power supplies are cooled by a dedicated cooling loop; see Section 4.1.2.3 of this SDD. As a loss of cooling would damage power supply components, cooling flow is interlocked to power. Cooling and water quality requirements are specified by ABB in submittal 24590-CM-POA-EBB0-00003-11-00007. Water quality:

- No glycol
- pH: 6.5 – 8.0
- Specific conductivity: 5 - 300 μS/cm
- Hardness: 5 – 7 mg/L as calcium carbonate
- Chlorine: < 0.2 ppm
- Copper: , 0.01 mg/L
- Total dissolved solids: << 145 mg/L
- Undissolved solids: << 1 mg/L (diameter of solids < 1 mm to prevent clogging)

To maintain water quality, 75 μS/cm limit has been set (CCN 250912). Water replacement is required in the event that conductivity of the water rises. The CCN estimates that water replacement could occur every 10 to 110 days. Provisions to maintain power to the melters must be available during cooling water replacement.

4.1.2.10 Melter Grounding

The four corners of the melter enclosure are connected to the LAW Facility grounding grid. The grounding plan is shown in 24590-101-TSA-W000-0010-409-844.

4.1.2.11 Other Melter Power

Discharge heater power and startup heater power is supplied through the LVE systems. Each melter has a power supply that services the two discharge chambers and heater assemblies, east and west. Each assembly has 12 heaters that are individually controlled. The power supplies are LVE-PSUP-20001 and LVE-PSUP-20002; they can be supplied by either LVE-MCC-20001 or LVE-MCC-20002 for redundant power availability. Normally, melter 1 is powered by the former, and melter 2 the MCC. The power supplies are located at elevation -21 ft rooms L-B002 and L-B004, respectively. Each MCC allocates cubicle 6 M for melter 1 and 7 M for melter 2.

4.1.2.12 Container and Handling

A container is filled with molten glass by the melter air lift and discharge chamber. As a consumable, the container does not have a system identifier. The container is described by the LRH system, which introduced the container into the facility. Containers are moved to the pour cave for filling, rooms L-B015A and L-B013C for melter 1 and rooms L-B013A and L-B011C for melter 2. Pour handling, LPH, will put a container in the turntable and lift it up to the pour spout by elevator. The melter pour spout lower bellows directly interfaces with the container top flange to limit air in-leakage. After filling, which takes about 7 hours at normal production rates, the container is lowered back to the turntable and an empty container is indexed to the elevator. The elevator will prove weight and location (limit switch) information to determine that a container is in position.

4.1.3 Physical Layout and Location

The melters are accessed from the melter gallery (Figure 4-10), room L-0112 and L-0130 above. The melter gallery includes two hoists on bridge and trolley systems to lift components and service the melters. The melters are moved into position on rails at elevation 3 ft with the gallery at elevation 22 ft, just about the level of the shield lid.

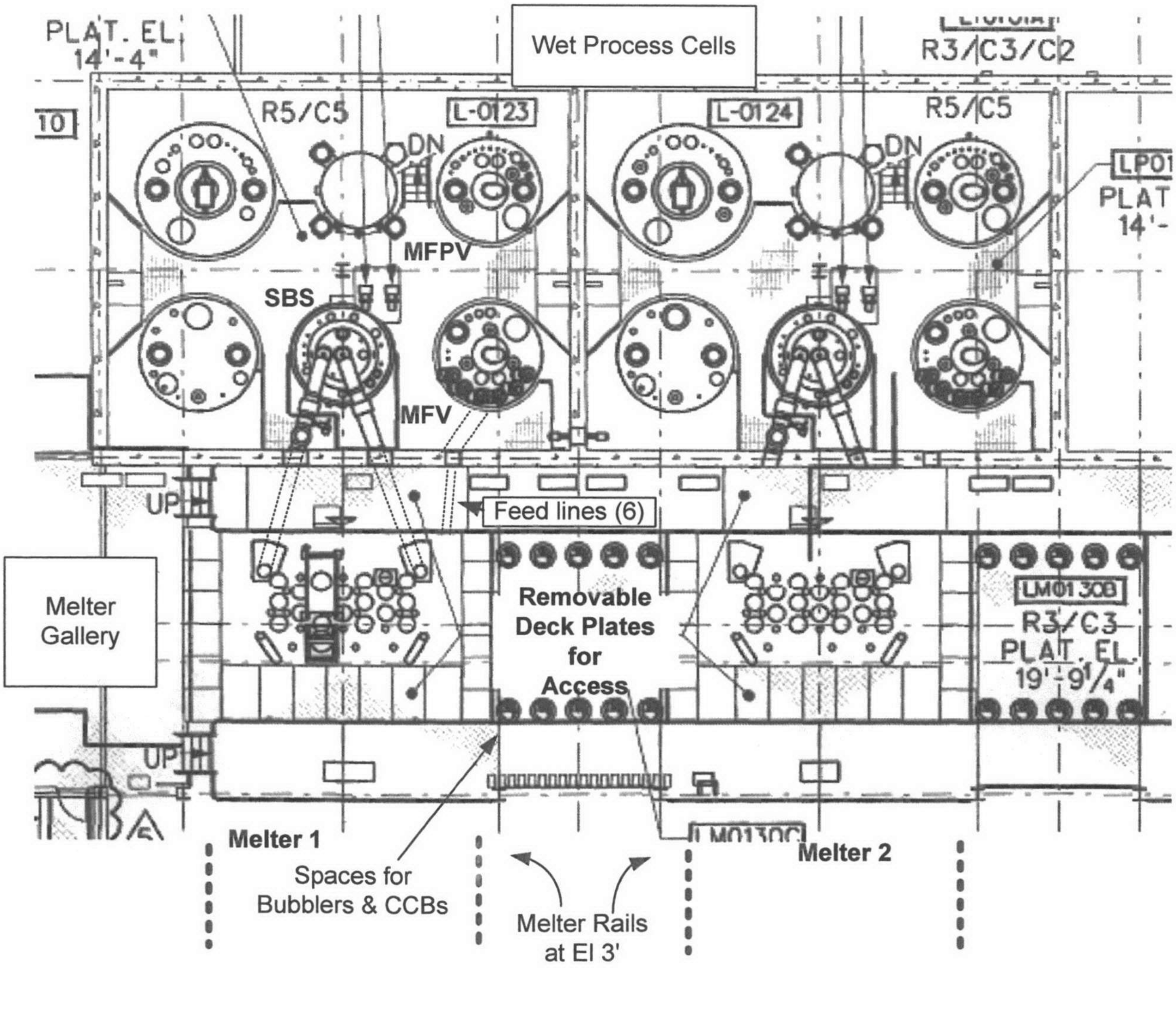


Figure 4-10 Melter Gallery

Interfacing equipment is positioned close by the melter in the wet process cell. The melter feed tanks are positioned just across a wall to the melter, providing a short and straight run for the feed slurry to travel. Similarly, the SBS is positioned so that the particulate laden offgas travels a short distance. Close proximity lessens the potential for blockages to develop.

Melter power supplies and cooling equipment are located at elevation -21 ft north of the pour cave, rooms L-B002 and L-B004.

4.1.4 Principles of Operation

Melter design is predicated on the properties of the glass being processed. Those properties are dependent on the glass composition. The product glass properties are also required to meet disposal regulations. Feed is prepared based on the waste batch composition, adding glass forming chemicals to reach a satisfactory glass. The melter is heated by passing current through the existing pool of glass. Feed slurry is heated by the glass. The feed boils off water, dries, and salts decompose and convert to oxide forms and fuse into glass. The conversion to glass is effected by the properties of the feed and the decomposition reactions. Additives, such as sugar, help these reactions proceed to the desired product. Feed preparation is the control point for all of these affects.

4.1.4.1 Feed Preparation

The feed preparation process occurs within the LCP and LFP systems. The specifics of tank homogeneity, sample accuracy, batch volumes, and transfers will be described in 24590-LAW-3ZD-LFP-00001, *LAW Melter Feed Process (LFP) and Concentrate Receipt Process (LCP) System Design Description.* Feed chemistry and conversion to glass is covered here. The WTP Contract, DOE 2000, defines three envelopes (A, B, and C) that describe the waste compositions processed in the LAW Facility. Tank characterization and the reality of Tank Farm Operations has shown that the waste composition is more a continuum of compositions. The soluble portion of tank waste is sent to LAW after cesium, a major radioactive constituent, is removed. This pretreated LAW waste is then, largely, a mixture of sodium sulfate, sodium nitrite, and sodium nitrate, with the ratio of alkali (sodium) to sulfur important to the glass composition.

Analysis of the pretreated waste in the concentrate receipt vessels (CRV) LCP-VSL-00001/2 provides the starting point for the glass. Each CRV holds waste for several feed batches, which will be prepared based on that analysis. A glass composition field has been determined and tested to transfer the waste into acceptable glass for both processing and disposal. The feed preparation process is completed in the melter feed preparation vessel (MFPV), LFP-VSL-00001/3. A portion of the CRV waste is sent to the MFPV and mixed with glass forming chemicals (GFC). The large amounts of nitrite and nitrate ions are mitigated by the addition of sugar. (Without sugar, unstable processing can result.) After the GFC are blended into the waste, a second sample, LAW-6, is taken to verify the expected composition. The verification is not part of the feed preparation process and is not a hold point; only gross errors in GFC addition would be detected by this sample. After sampling, the prepared feed can be pumped through a bulge to the melter feed vessel, LFP-VSL-00002/4.

A feed preparation algorithm[1] has been developed to take the waste analysis and compute a glass composition within the acceptable boundaries of "good glass." Table 4-4 provides a listing of the properties and acceptance values for each of the properties that must be attained. Discussion of glass properties is below. The uncertainties associated with each measurement are used to account for the "worst" outcome for the property. The algorithm further computes and documents the final glass composition in containers accounting for the mixing process in

[1] 24590-LAW-RPT-RT-04-0003, *Preliminary ILAW Formulation Algorithm Description.*

the melter. The algorithm and attention to the feed preparation process will provide assurance that melter operation will not be impeded by the glass.

Table 4-4 Summary of LAW Glass and Melt Constraints Used in ILAW Algorithm[(a)]

Constraint Description	Constraint
Product consistency test (PCT) normalized releases of Na, B, and Si	< 2 (g/m^2) (for Na, B, and Si)
Vapor hydration test (VHT) 200°C alteration rate	< 50 ($g/m^2/d$)
Viscosity at 1100 °C	≤ 150 (P)
Viscosity at 1150 °C	≥ 20 (P)
Viscosity at 1150 °C	≤ 80 (P)
Electrical conductivity at 1100 °C	≥ 0.1 (S/cm)
Electrical conductivity at 1200 °C	≤ 0.7 (S/cm)
Waste loading (wt% waste Na_2O in glass)	> 14, 3, and 10 (wt%) for envelopes A, B, and C LAW, respectively
Waste classification	< Class C limits as defined in 10CFR61.55
^{90}Sr activity per unit volume of glass	< 20 (Ci/m^3)
^{137}Cs activity per unit volume of glass (waste form compliance)	< 3 (Ci/m^3)
^{137}Cs activity per unit volume of glass (system maintenance)	< 0.3 (Ci/m^3)
Canister surface dose rate	≤ 500 mrem/h

(a) ILAW must also meet the Dangerous Waste Limitations (Contract specification paragraph 2.2.2.20, DOE 2000) although this specification is not listed in this table because there is no calculation required to be performed by the ILAW algorithm (see text above this table).

Large quantities of ILAW glass will be produced at the WTP. The glass will hold up to about 20 wt% alkali and a total waste loading of about 25 wt%. The rest of the glass is GFCs. The GFCs selected by the WTP Project are mostly low cost minerals, delivered in bulk quantities. Each GFC is stored separately in a silo and weighted out by an automated system at the GFR Facility. Silos are grouped into subsystems; each group has a weigh-feeder and a transporter that weighs out the desired quantity from each silo, in turn, and sends the material to a blender in the GFR Facility. The final mixture in the blender is pneumatically transferred to one of two mixers positioned over each MFPV for final gravity transfer. Weights are checked and verified several times through this process. Table 4-5 provides a list of the GFCs of some properties and its general purpose in the glass. Structural elements provide the glass a three-dimensional matrix, and they increase durability and viscosity. Intermediates can behave like structural components or more like modifiers; however, their capacity for multiple bonds allow other additions. Modifiers interrupt the structure acting as ion bonding to non-bridging oxygen. Modifiers tend to decrease viscosity and increase conductivity.

Table 4-5 Glass Forming Chemicals

Oxide Added	Purpose	Mineral	GFR Sub-Sys	Grade	Bulk Density Lbm/ft^3
Al_2O_3	Intermediate	Kyanite - Al_2O_2-SiO_2	200	Raw –325 Mesh	56 – 101
B_2O_3	Structure	Boric Acid - H_3BO_3	200	Technical Grade-Granular	55 – 59
Na_2O/B_2O_3	Mod/ Struc	10M Borax - $Na_2B_4O_7$-$10H_2O$	400	Technical 10 Mole Borax	48 – 54
Na_2O	Modifier	Na_2CO_3 Anhydrous	400	Dense Soda Ash	64 – 68
CaO	Modifier	Wollastonite - $CaSiO_3$	200	NYADM325	46 – 77
Fe_2O_3	Intermediate	Fe_2O_3	500	5001	89 – 141
Li_2O	Modifier	Li_2CO_3	300	Technical Grade	53 -72
MgO	Intermediate	Olivine	500	#180	89 – 98
SiO_2	Structure	SiO_2	100	SCS-75	50 – 89
TiO_2	Intermediate	Rutile TiO_2/Fe_2O_3	500	Air Floated Rutile 94	91 – 135
ZnO	Modifier	ZnO	300	Kadox 920	31 – 66
ZrO_2	Structure	$ZrSiO_4$	500	Zircon flour	96 – 155
$C_{12}H_{22}O_{11}$	Redox control	Sugar	200	Granular	53 - 56

GRCs in shaded rows are not normally used in LAW recipes.

4.1.4.2 Volatilization and Decomposition – Cold Cap Chemistry

Feed from the ADS pumps enter the melter through six water cooled feed nozzles. The slurry freefalls from the feed nozzle about 3-¼ ft to the melt surface below. Volatile organics and water boils off quickly; the remainder of the slurry lands on the glass surface, quickly forming an oxide layer. Destruction of volatile organic compounds in the melter is limited, because their residence time is low. For example, only 10 -15 % of the added allyl alcohol was destroyed in a melter during testing. The solids form an intermediate zone in the melter called the cold cap. The solids can build up to several inches thick with pockets of liquid feed boiling of top. In the cold cap, salts and nonvolatile organic compounds begin to decompose. The cold cap is a dynamic environment, ridges can form, open glass can be exposed as bubblers break through the cold cap (later to be covered over), and liquid pools can have their banks broken off or eroded so that the liquid runs to open areas, causing a flash of steam. The resulting gases, mostly steam, NO_x, SO_x, CO_2, and some CO and NH_3, vary in concentration due to the dynamic action in the cold cap. Both slurry and glass particulate can be entrained or launched into the offgas flow and carried out of the melter. Hot glass, circulated by the bubblers, increases heat transfer to the cold cap and helps to incorporate solids into the melt.

The goal of the operation is to stabilize this active melt surface as much as possible. Feed rate is set and adjusted to produce a large cold cap covering over 95 % of the surface. (Note that surface coverage descriptions are subjective; actual control actions will respond to plenum temperature.) With a minimum of open glass, the plenum temperature drops to around 400 °C. The cooler plenum will minimize the loss of semivolatile elements, such as cesium and lead, to the offgas. Over feeding and allowing the cold cap to grow too big will lower the plenum temperature, but a large feed inventory will lead to pressure surges as accumulated liquid reaches hot glass. A combination of feed rate, as the primary adjustment, and bubbling rate as a secondary adjustment, will be used to regulate the cold cap using plenum temperature in general with localized hot or cool spots as guides. In general, a higher feed rate will lower the plenum temperature and increase the size of the cold cap. Adjustments to any of melter parameters must be done in a deliberate manner. The size and mass of the melter means that several hours will be needed for the full effect of adjustments to be realized. Initial parameters for melter operation will be set based, in part, on pilot melter test experience.

4.1.4.3 Glass Properties

Glass property requirements are listed in Table 4-4. The algorithm will 1) maximize batch size in the MFPV; 2) maximize waste loading to meet Contract limits; and 3) meet all of the property requirements listed in Table____. As mentioned above, glass formulation is handled as a continuum of compositions and glass property models have been constructed to that range of compositions. The importance of each property is discussed below:

- Leach resistance or durability is a regulatory requirement for land disposal. The product consistency test (PCT) and vapor hydration test (VHT) have been tailored to measure glass durability. A candidate glass must pass both tests, which also means it would pass the less aggressive toxicity characteristic leaching procedure (TCLP) limits typically applied. The PCT tests leached components from ground glass after 7 days in 90 °C water environment. The VHT tests surface alteration of glass in a 7 day test at 200 °C.
- The viscosity of glass must be low enough to pour out of the melter without dripping or wicking and fill a container out to the walls. However, if the glass is too thin, it will seep through the cracks in the refractory and accelerate damage. Glass migration could also electrically short out the melter.
- Electrical conductivity of the glass, together with melter geometry, defines the power circuit resistance. The power supply design must supply both current and voltage to the melter to accommodate normal system variations. For example, there is a current limit on the circuit based on the conductor / transformer size, if the voltage required to deliver that current is low (high conductivity), then not enough power will be generated to keep the melter hot.
- Waste loading is controlled by the ratio of sodium to sulfur. A high sulfur waste will be limited in the amount of sodium can be in the glass. The limits for each envelope are based on the expected sulfur in that type of waste.
- A container of LAW is limited in how much radioactivity can be present, and its surface dose rate. The site burial ground will only handle Class C waste or less. The WTP also has a more restrictive limit because the WTP Project expects to perform hands-on maintenance of LAW equipment.

4.1.4.4 Glass Compliance

The product of the LAW process is ILAW, which is borosilicate glass. Producing a waste form suitable for disposal is one of the top-level contract requirements for the WTP. High temperature processing drives elements to the oxide state. At lower temperatures (500-600 °C), the process is called calcination where individual or blended oxides form. Vitrification allows for the fusing of the oxides together into a glass matrix, which provides the chemical durability of the form. The feed preparation process provides the glass forming chemicals to produce the glass with the desired properties. Silicon, boron, and aluminum oxides form the backbone of the glass matrix.

The glass must conform to melter design requirements and disposal requirements for the Hanford Integrated Disposal Facility. Tank farm waste is classified as mixed waste, both radioactive and dangerous or hazardous. Both Washington State Dangerous Waste Regulation (WAC 173-303-140) and the Land Disposal Regulations rules of the *Resource Conservation and Recovery Act* (RCRA) apply to LAW waste (40 CFR 268). To satisfy Land Disposal Regulation rules, glass testing data has been collected to form the basis for a variance petition to Washington State Department of Ecology (Ecology) and the US Environmental Protection Agency (EPA). The WTP Project is seeking a variance from some LDR rules, like sampling and testing the product glass, because of ALARA considerations. The petition shows that the WTP Project will produce a waste with equivalent or greater margin of safety as specified in the regulations.

The WTP Project produced 24590-WTP-PL-RT-03-001, *ILAW Product Compliance Plan*, which describes the package and documents the strategy needed to produce containers compliant with all requirements. Report 24590-LAW-RPT-RT-05-001, *ILAW Product Qualification Report*, documents results of analyses and testing to support the compliance strategies, and describes the documentation that provides the basis for certifying that waste package conforms to WTP Contract, DOE 2000, requirements. Planned implementation of this strategy by Operations is described in 24590-LAW-RPT-OP-11-001, *Batch Plan Methodology for the Low Activity Waste Facility*, Rev A.

As demonstrated in extensive melter testing, the feed composition, minus a small portion of volatile elements, directly defines the glass composition and the glass properties. Feed enters the melter, water evaporates, solids decompose, calcine, and fuse into glass, all in the cold cap. The glass then mixes into the bulk glass pool of the melter. As glass inventory accumulates in the melter, it is air lifted to a container.

4.1.5 System Reliability Features

Reserved

4.1.6 System Control Features

4.1.6.1 Functions

The melter functions were analyzed and deconstructed in Section 2.1 of this SDD. The main process functions are listed below:

- Maintain glass pool temperature
- Melt the cold cap and agitate the glass pool
- Maintain glass pool level
- Monitor melter plenum temperature
- Maintain plenum pressure
- Lift molten glass to discharge chamber and fill container

These six functions are implemented in three control strategies that integrate into melter operations

Glass temperature control provides the starting point for glass and plenum temperatures, as well as the temperature gradient through the melter refractory as assisted by the air and water cooling circuits around the melter.

Although feed and pressure control is provided by interfacing systems, adjustment to these systems are made based on feedback from the melter. Feed pulsing from ADS pumps forms the cold cap, which in turn regulates the plenum temperature. The cold cap results in glass production and pool level increase. The variable gas generation rates from the cold cap challenge the offgas systems to maintain pressure control within the melter. Loss of pressure control results in a termination of feed additions, which will restore stable operation. Excess feeding can result in unstable cold cap behavior, complicating pressure control.

Glass pour operations are regulated by melter pool level. Feed increases pool level and air lifting glass decreases the level. Batch pour sequences are required to generate sufficient glass mass to flow into a container and spread to the container walls, ensuring adequate fill with no voids. Control of the discharge section temperature and pressure facilitate control of the glass pour.

4.1.6.2 Summary

Vitrification of LAW requires processing a prepared feed at 1150 °C to produce a durable immobilized waste form. The high temperature and massive nature of the refractory assembly means that changes to the bulk temperature occur over many hours. Changes to feed rate in response to temperature fluctuations must be done deliberately and slowly to avoid problems due to over control. Conversely, melter pressure changes very quickly.

The control system is preloaded with a base airflow to accommodate the large amount of steam and air effluent. Adjustment to the added air can be accomplished on a time scale to respond to the pressure fluctuations. Pressure control is an interface requirement to systems LOP and LVP. Utility services to the melter provide cooling, which defines the temperature gradient in the refractory per design.

The following feed shutdown interlocks will cause the ADS pumps to shut down normally, with water flush. Several interlocks are requirements included in the WTP Dangerous Waste Operating Permit as automatic waste feed cut off (AWFCO) limits (proposed). Any AWFCO limit violation will have specific reporting requirement which will be detailed in the procedures. Note that this list (and set points) will be negotiated with Ecology and could change.

- Maximum total waste feed rate (time weighted average) 250 gal/hr/melter
- Melter average plenum LO-LO temperature, LMP-TI-1263G /LMP-TI-2263G
- Back up film cooler bypass valve open
- HEPA filter HI-HI differential pressure, LVP-PDI-0007/ LVP-PDI-08/ LVP-PDI-11/ LVP-PDI-12
- Minimum offgas temperature at SCO bed inlet -660 °F
- Only one exhauster running (two required)
- Caustic scrubber bypass open LVP-YV-0097
- Mercury absorber bypass open, LVP-YV-0403
- Catalyst skid bypass open, LVP-YV-0501
- Mercury concentration high, LVP-AI-0423A
- Melter feed tank LO-LO level, LFP-LI-1146A
- SBS LO-LO level or HI-HI level, LOP-LI-1063
- Bypass valve(s) open for greater than time limit (sec) **TBD**

The following SS feed interlocks do not shut down the feed pumps, but cut off air and flush water to the pumps instantaneously to stop slurry transfer. Also, see Section 4.5 of this SDD on pressure control for more detail.

- Melter plenum HI-HI pressure, in system PCJ: LMP-PDI-1410, LMP-PDI-11, LMP-PDI-2410, LMP-PDI-11 (-3.25 in WC)
- Melter plenum HI-HI pressure in the PPJ system (AWFCO), LMP-PDI-1528 and LMP-PDI-1529; LMP-PDI-2528 and LMP-PDI-2529 (-1 in WC). This alarm latches in and must be manually reset to continue operating.

A summary level interface and instrumentation diagram is shown as Figure 4-11.

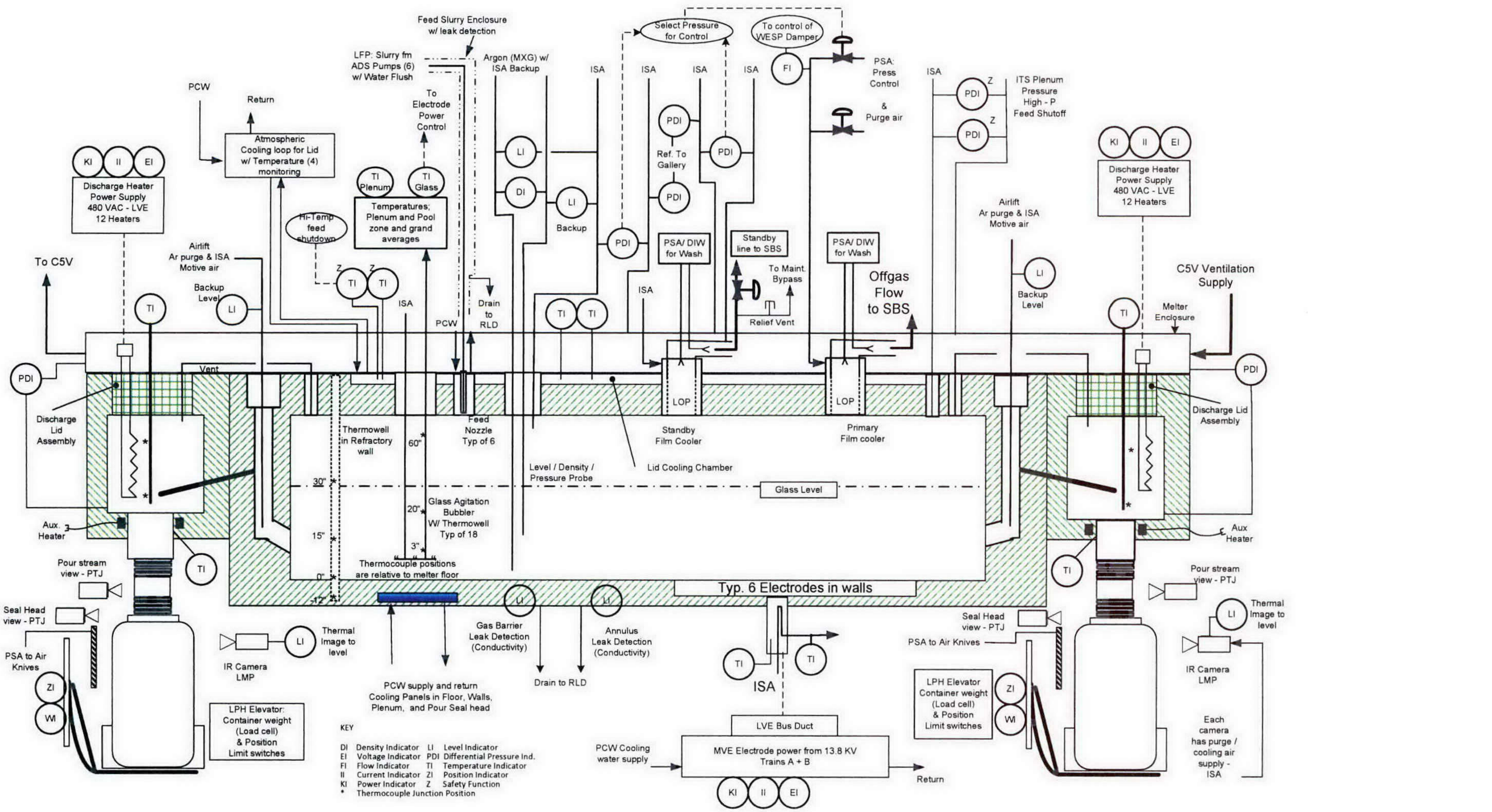


Figure 4-11 Summary P&ID

4.2 Operations

4.2.1 Initial Configuration (Pre-startup)

Reserved

4.2.2 System Startup

Reserved

4.2.3 Normal Operations

Reserved

4.2.4 Off-Normal Operations

Reserved

4.2.5 System Shutdown

Reserved

4.2.6 Safety Management Programs and Administrative Controls

Reserved

4.3 Testing and Maintenance

4.3.1 Temporary Configurations

Reserved

4.3.2 TSR-Required Surveillances

Reserved

4.3.3 Non-TSR Inspections and Testing

Reserved

4.3.4 Maintenance

Reserved

4.4 Supplemental Information

Reserve

5 References and Design Documents List

5.1 Source / Basis References

Document Number	Rev	Title	Text Reference
24590-WTP-DB-ENG-01-001	002	Basis of Design	BOD
24590-WTP-PL-RT-03-001	005	ILAW Product Compliance Plan	ILAW
24590-WTP-PSAR-ESH-01-002-03	05K	Preliminary Documented Safety Analysis to Support Construction Authorization; LAW Facility Specific Information	PDSA-LAW
24590-WTP-RPT-OP-01-001	005	Operations Requirements Document	ORD
24590-WTP-SRD-ESH-01-001-02	7F	Safety Requirements Document – Volume II	SRD
DE-AC27-01RV14136	N/A	DOE. 2000. DOE Contract DE-AC27-01RV14136. *Hanford Tank Waste Treatment and Immobilization Plant,* as amended. US Department of Energy, Richland Operations Office, Richland, WA.	DOE 2000
WA7890008967, Part 3	N/A	Dangerous Waste Portion of RCRA Permit	DWP

5.2 Other References

Document Number	Rev	Title
24590-101-TSA-W000-0010-409-058	00C	*Final - 100% Design - LAW, Feed Nozzle Assembly*
24590-101-TSA-W000-0010-409-059	00B	*95% Design - LAW, Feed Nozzle Assembly*
24590-101-TSA-W000-0010-409-060	00C	*Final - 100% Design - LAW, Feed Nozzle Head Assembly*
24590-101-TSA-W000-0010-409-069	00C	*Final - 100% Design - LAW, Level Detector Assembly*
24590-101-TSA-W000-0010-409-070	00B	*95% Design - LAW, Level Detector Assembly*
24590-101-TSA-W000-0010-409-080	B00	*Drawing - LAW Melter Air Lift Lance Assembly*
24590-101-TSA-W000-0010-409-101	00B	*95% DESIGN - Start-Up Heater Assembly*
24590-101-TSA-W000-0010-409-1137	00A	*95% Design Report- LAW Melter Life Report*
24590-101-TSA-W000-0010-409-1157	00B	*Final - 100 Percent Design - LAW, Bubbler Assembly*
24590-101-TSA-W000-0010-409-763	00C	*Final 100% Design - LAW, Stand-By Film Cooler Assembly, WTP-M-12630*
24590-101-TSA-W000-0010-409-779	00C	*Final - 100% Design - LAW, Main Off Gas Assembly*
24590-101-TSA-W000-0010-409-823	00B	*Final - 100% Design - LAW, Discharge Chamber Vent Assembly WTP-M-12800, Rev. 001*

Document Number	Rev	Title
24590-101-TSA-W000-0010-409-834	00B	*95% Design - LAW, Large Lid Plug Assembly, WTP-M-12900*
24590-101-TSA-W000-0010-409-839	00B	*95% Design - LAW, Medium Lid Plug Assembly, WTP-M-12910*
24590-101-TSA-W000-0010-409-842	00B	*95% Design - LAW, Small Lid Plug Assembly*
24590-101-TSA-W000-0010-409-844	NA	*90% Design - LAW, Melter Grounding Plan WTP-E-13050, REV. 000*
24590-101-TSA-W000-0010-42-02	00B	*Report - LAW Melter Materials Selection*
24590-CM-POA-EBB0-00003-11-00007	00C	*Data Sheet - LAW - Data Sheet Cooling Water System*
24590-CM-POA-EEC0-00001-09-00001	00B	*Analysis - Airflow Analysis for LAW Pour Head Viewing and Container Viewing Camera*
24590-HLW-RPT-RT-05-001	001	*Preliminary IHLW Formulation Algorithm Description*
24590-LAW-3PS-AE00-T0001	006	*Engineering Specification for Low Activity Waste Melters,*
24590-LAW-E1-LVE-00029	002	*LAW Vitrification Building Melter 1 & 2 Start-Up Heaters Single Line Diagram*
24590-LAW-FHA-RAFP-FP-0001	001	*Fire Hazards Analysis (FHA) for the Low-Activity Waste Facility (LAW)*
24590-LAW-J3-LMP-01013	002	*Functional Diagram Melter 1 Glass Level Detection Instruments*
24590-LAW-J3-LMP-01015	002	*Functional Diagram Melter 2 Glass Level Detection Instruments*
24590-LAW-JVC-LMP-00002	002	*LAW Melter Lid Cooling PSV Sizing*
24590-LAW-JVC-LMP-00003	001	*LAW Melter Lid Cooling Heat Exchanger PSVs Sizing*
24590-LAW-M2C-LMP-00001	000	*Thermal Analysis of Gas Barrier Lid LAW Melter Lid CFD Analysis*
24590-LAW-M2C-M80T-00001	00B	*LAW Melter Lid Stress Analysis / Summary*
24590-LAW-M2C-M80T-00003	00B	*LAW Melter Lid Refractory Thermal/Structural Finite Element Analysis using ANSYS*
24590-LAW-M6-LMP-00002002	000	*P&ID - LAW Melter Process System Melter 1 Agitation Zone 3 and Level Detection LMP-RK-00040C*
24590-LAW-M6-LMP-00032002	000	*P&ID - LAW Melter Process System Melter 2 Agitation Zone 3 & Level Detection LMP-RK-00041C*
24590-LAW-N1D-LMP-00001	000	*LMP-MLTR-00001 & LMP-MLTR-00002 - LAW Melter 1 and Melter 2 Gas Barrier and Cooling Panels*
24590-LAW-N1D-LMP-00002	000	*LMP-TK-00001 & LMP-TK-00002 (PTF) - Corrosion Evaluation - Melter 1 & Melter 2 Lid Cooling Loop Makeup Water Tanks*
24590-LAW-RPT-ENS-12-001	000	*LAW Post Accident Monitoring Report*
24590-LAW-RPT-OP-11-001	00A	*Batch Processing Methodology For Low Activity Waste Facility*
24590-LAW-RPT-RT-04-0003	001	*Preliminary ILAW Formulation Algorithm Description*
24590-LAW-RPT-RT-05-001	000	*The ILAW Product Qualification Report for the Hanford Tank Waste Treatment Andand Immobilization Plant*
24590-LAW-U0D-W16T-00001	002	*LAW Room Environment Data Sheet*
24590-LAW-VDCN-ML-06-00104	N/A	*WTP-M-11950, Sheet 1, Rev. 2: Part Number Clarification*
24590-LAW-VDCN-ML-06-00105	N/A	*WTP-M-12800, Sheet 1, Rev. 1: Add Line Items*
24590-LAW-VDCN-ML-06-00107	N/A	*WTP-M-12808, Sheet 1, Rev. 1: Add Line Items*
24590-LAW-VDCN-ML-15-00005	ADM	*WTP-M-11805: Gas Barrier Lid Refractory Expansion Joints And Build to Fit Dimensions*

Document Number	Rev	Title
24590-LAW-MVC-LFP-00001	000	*LAW Melter Feed Process System (LFP) Data*
24590-QL-HC4-W000-00011-03-00468	00B	*Drawing - LAW - Bubbler Assembly*
24590-QL-HC4-W000-00011-03-00469	00A	*Drawing - Start-Up Heater Assembly*
24590-QL-HC4-W000-00011-03-00473	00A	*Drawing - Large Lid Plug Assembly*
24590-QL-HC4-W000-00011-03-00474	00A	*Drawing - Medium Lid Plug Assembly*
24590-QL-HC4-W000-00011-03-00475	00A	*Drawing - Small Lid Plug Assembly*
24590-QL-HC4-W000-00011-03-00482	00A	*Drawing - Frit Addition Assembly*
24590-QL-HC4-W000-00011-03-00601	00A	*Drawing - LAW - Bubbler Assembly*
24590-QL-HC4-W000-00011-03-00602	00A	*Drawing - LAW - Bubbler Assembly*
24590-QL-HC4-W000-00094-03-00001	00A	*Report - LAW Melter Design Basis Report*
24590-QL-HC4-W000-00094-05-00003	00A	*LAW Melter In-Leakage And Purge Flow Rates*
24590-QL-YQA-MEEM-10135	000	*Low Active Waste Melter Fabrication and Assembly - Peterson Inc.*
24590-QL-YQA-MEEM-10136	001	*Low Active Waste Melter Fabrication and Assembly - Peterson Inc*
24590-WTP-3DP-G03B-00044	009	*Standard Component Numbering*
24590-WTP-3DP-G04B-00046	031	*Engineering Drawings*
24590-WTP-3PS-P000-T0001	006	*Engineering Specification For Piping Material Classes General Description and Summary*
24590-LAW-3ZD-LFP-00001	000	*LAW Melter Feed Process (LFP) and Concentrate Receipt Process (LCP) System Design Description.*
24590-LAW-3ZD-LRH-00001	000	*LAW Container Receipt Handling (LRH) System Design Description*
24590-WTP-3YD-PCW-00001	002	*System Design Description for the WTP Plant Cooling Water System (PCW)*
24590-WTP-DB-ENG-01-001	002	*Basis of Design*
24590-WTP-DB-PET-09-001	001	*Process Inputs Basis of Design (PIBOD);*
24590-WTP-DC-ST-04-001	04A	*Seismic Analysis and Design Criteria*
24590-WTP-GPG-ENG-0161	000	*Technical Requirements Management*
24590-WTP-GPG-ENG-033	003	*Evaluation for Seismic Interaction Effects*
24590-WTP-GPG-M-036	007	*Determining Quality Level and Seismic Category Classification of Sub-Components, Assemblies, Sub-Assemblies, and Parts*
24590-WTP-GPP-SQP-208	03B	*Plant Software Life Cycle Management*
24590-WTP-M4C-V11T-00024	006	*WTP Process Flowsheet Mass & Energy Balance Analysis for Input to Material Selection Assessments*
24590-WTP-PSAR-ESH-01-002-01	05F	*Preliminary Documented Safety Analysis to Support Construction Authorization; General Information*
24590-WTP-QAM-QA-06-001	016	*Quality Assurance Manual*
24590-WTP-RPT-ENG-01-001	06D	*Technical Baseline Description*
24590-WTP-SDDR-ML-07-00117	N/A	*WTP-M-11806, WTP-M-11811, WTP-M-11816: Gas Barrier Lid Re-Design*
24590-WTP-SDDR-ML-08-00009	001	*WTP-M-11806; Lid Frame Assembly Drawings*
24590-WTP-SDDR-ML-08-00217	N/A	*6133-11806; Lid Frame Assembly*

Document Number	Rev	Title
24590-WTP-SDDR-ML-08-00317	N/A	*WTP-M-12300 Sheet 1: Air Lift Lance Assembly (NCR# B02970)*
24590-WTP-SDDR-ML-08-00329	N/A	*WTP-M-11806: Counteract Gas Barrier Lid Welding Distortion*
24590-WTP-SDDR-ML-09-00001	N/A	*WTP-M-11806: Lid Frame Assembly Modifications / Revisions*
24590-WTP-SDDR-ML-09-00033	N/A	*WTP-M-11806, Sheet 1: East Lid Frame Assembly (NCR #B03118)*
24590-WTP-SDDR-ML-09-00035	N/A	*WTP-M-11806: Lid Frame Assembly Modifications/Revisions*
24590-WTP-SDDR-ML-09-00045	N/A	*WTP-M-11806, Sheet 2: Lid Frame Assembly - Gas Barrier Lid # 1 (NCR #B03189)*
24590-WTP-SDDR-ML-09-00049	N/A	*6133-11806, Sheet 12: Gas Barrier Lid Assembly - Out-Of-Tolerance (NCR B03208)*
24590-WTP-SDDR-ML-09-00051	N/A	*6133-11806, Sheet 6: Gas Barrier Lid Assembly - Thread Depth (NCR #B03213)*
24590-WTP-SDDR-ML-09-00053	001	*6133-11806: Lid Frame Assembly - Incorporate Modifications To Drawing Sheets 1-24*
24590-WTP-SDDR-ML-09-00059	N/A	*6133-11806: Gas Barrier Lid Assembly #2 (Weld Distortion Affecting Port Flange Thicknesses)*
24590-WTP-SDDR-ML-09-00065	N/A	*WTP-M-11806: Lid Frame Assembly - Out-Of-Tolerance (NCR #B03350)*
24590-WTP-SDDR-ML-09-00067	N/A	*6133-11806: Gas Barrier Lid Assembly - Out-Of-Tolerance (NCR #B03359)*
24590-WTP-SDDR-ML-09-00073	N/A	*6133-11806: Gas Barrier Lid Frame Assembly (SHEETS 1-24, REV. 7)*
24590-WTP-SDDR-ML-09-00085	N/A	*6133-11806, Sheet 2: Lid Frame Assembly - Out Of Tolerance (NCR #B03493)*
24590-WTP-TQ-G-01-024	000	*Pours Caused By Glass Foaming*
24590-WTP-TQ-G-03-066	N/A	*LAW Pour Spout Bellows Manufacturers Information*
24590-WTP-VDCN-ML-05-00412	N/A	*WTP-M-11805 Sheet 1 Rev. 2 Add Line Item and Figure*
ASTM E 119	N/A	*Standard Test Methods for Fire Tests of Building Construction and Materials*
CCN 250912	N/A	*Supersedes CCN 250907: Conductivity Rise in Melter Power Supply Process Cooling Water (PCW) Loop*
CCN 271242	N/A	*24590-QL-SRA-HXYG-00116 Revision 3 Activity 3-3; Evaluate High Level Waste (HLW) And Low Activity Waste (LAW) Melter Plenums for Steam Explosions and Acute Steaming Completion with the Issuance of Fai/14-0627 Revision 0, Steam Explosions with Molten Glass*
DE-AC27-01RV14136*	M339	*DOE/BNI WTP Contract Mod No. 334, Section C – Statement of Work, Hanford Tank Waste Treatment and Immobilization Plant*
DOE-STD-3024-2011	N/A	*Content of System Design Descriptions*
*DOE. 2000. DOE Contract DE-AC27-01RV14136. *Hanford Tank Waste Treatment and Immobilization Plant,* as amended. US Department of Energy, Richland Operations Office, Richland, WA.		

5.3 System Design Documents

Document Number	Title
Process Flow Diagrams	
24590-LAW-E1-LVE-00029	*LAW Vitrification Building Melter 1 & 2 Start-Up Heaters Single Line Diagram*
24590-LAW-E1-LVE-00031	*LAW Vitrification Building Melter 1 Discharge Heaters Single Line Diagram*
24590-LAW-E1-MVE-00001	*LAW Vitrification Building Power Distribution Main Single Line Diagram*
24590-LAW-E1-MVE-00003	*LAW Vitrification Building 13.8kv Switchgear Mve-Swgr-20603 & 20604 Single Line Diagram*
24590-LAW-E1-MVE-00004	*LAW Vitrification Building Melter - LMP System Electrode Power Supply Single Line Diagram*
24590-LAW-M6-LMP-00001001	*P&ID - LAW - Law Melter Process System Melter 1 Agitation Zone 1 & Zone 2 LMP-RK-00040A/B*
24590-LAW-M6-LMP-00002001	*P&ID - LAW Melter Process System Melter 1 Agitation Zone 3 And Level Detection LMP-RK-00040B AND PPJ-RK-00001*
24590-LAW-M6-LMP-00002002	*P&ID - LAW Melter Process System Melter 1 Agitation Zone 3 And Level Detection LMP-RK-00040C*
24590-LAW-M6-LMP-00003001	*P&ID - LAW - LAW Melter Process System Melter 1 Walls And Floor Panels Cooling System*
24590-LAW-M6-LMP-00004001	*P&ID - LAW - LAW Melter Process System Lmp-Mltr-00001/-00002 Start-Up Heaters*
24590-LAW-M6-LMP-00005001	*P&ID - LAW - LAW Melter Process System Melter 1 Electrode Extension Cooling & Glass/Plenum Temperatures*
24590-LAW-M6-LMP-00007001	*P&ID - LAW - LAW Melter Process System Melter 1 Glass Pouring And Monitoring Instrumentation*
24590-LAW-M6-LMP-00007002	*P&ID - LAW - LAW Melter Process System Melter 1 Glass Pouring And Monitoring Instrumentation*
24590-LAW-M6-LMP-00008001	*P&ID - LAW - LAW Melter Process System Melter 1 Discharge Heaters, Power Controls (1-4) & Air Lift - Eastside*
24590-LAW-M6-LMP-00009001	*P&ID - LAW - LAW Melter Process System Melter 1discharge System-Eastside Discharge Heater Power Controls (5-12)*
24590-LAW-M6-LMP-00010001	*P&ID - LAW - LAW Melter Process System Melter 1 Discharge Heaters, Power Controls (1-4) & Air Lift - Westside*
24590-LAW-M6-LMP-00011001	*P&ID - LAW - LAW Melter Process System Melter 1 Discharge System-Westside Discharge Heater Power Controls (5-12)*
24590-LAW-M6-LMP-00012001	*P&ID - LAW - LAW Melter Process System Melter 1 Feed Nozzles Cooling System and Feed Nozzles*
24590-LAW-M6-LMP-00013001	*P&ID - LAW - LAW Melter Process System Melter 1 Lid, Plenum And Offgas Ports Cooling System*
24590-LAW-M6-LMP-00013002	*P&ID - LAW - LAW Melter Process System Melter 1 Melter Lid Cooling Loop*
24590-LAW-M6-LMP-00014001	*P&ID - LAW - LAW Melter Process System Melter 1 Cooling Water Supply & Return Header*
24590-LAW-M6-LMP-00031001	*P&ID - LAW - LAW Melter Process System Melter 2 Agitation - Zone 1 & Zone 2*
24590-LAW-M6-LMP-00032001	*P&ID - LAW Melter Process System Melter 2 Agitation Zone 3 & Level Detection LMP-RK-000041B & PPJ-RK-00002*

Document Number	Title
24590-LAW-M6-LMP-00032002	*P&ID - LAW Melter Process System Melter 2 Agitation Zone 3 & Level Detection LMP-RK-00041C*
24590-LAW-M6-LMP-00033001	*P&ID - LAW - LAW Melter Process System Melter 2 Walls And Floor Panels Cooling System*
24590-LAW-M6-LMP-00035001	*P&ID - LAW - LAW Melter Process System Melter 2 Electrode Extension Cooling & Glass/Plenum Temperatures*
24590-LAW-M6-LMP-00037001	*P&ID - LAW - LAW Melter Process System Melter 2 Glass Pouring And Monitoring Instrumentation*
24590-LAW-M6-LMP-00037002	*P&ID - LAW - LAW Melter Process System Melter 2 Glass Pouring And Monitoring Instrumentation*
24590-LAW-M6-LMP-00038001	*P&ID - LAW - LAW Melter Process System Melter 2 Discharge Heaters, Power Controls (1-4) & Air Lift - Eastside*
24590-LAW-M6-LMP-00039001	*P&ID - LAW - LAW Melter Process System Melter 2 Discharge System-Eastside Discharge Heater Power Controls (5-12)*
24590-LAW-M6-LMP-00040001	*P&ID - LAW - LAW Melter Process System Melter 2 Discharge Heaters, Power Controls (1-4) & Air Lift - Westside*
24590-LAW-M6-LMP-00041001	*P&ID - LAW - LAW Melter Process System Melter 2 Discharge System-Westside Discharge Heater Power Controls (5-12)*
24590-LAW-M6-LMP-00042001	*P&ID - LAW - LAW Melter Process System Melter 2 Feed Nozzles Cooling System and Feed Nozzles*
24590-LAW-M6-LMP-00043001	*P&ID - LAW - LAW Melter Process System Melter 2 Lid, Plenum And Offgas Ports Cooling System*
24590-LAW-M6-LMP-00043002	*P&ID - LAW - LAW Melter Process System Melter 2 Melter Lid Cooling Loop*
24590-LAW-M6-LMP-00044001	*P&ID - LAW - LAW Melter Process System Melter 2 Cooling Water Supply & Return Header*
24590-LAW-M6-LMP-00091001	*P&ID - LAW - LAW Melter Process System Melters 1 And 2 Electrode Power Supplies*
24590-LAW-M6-PCW-00001001	*P&ID - LAW Plant Cooling Water System Distribution*
24590-LAW-M6-PCW-00002001	*P&ID - LAW Plant Cooling Water System Melters Power Supply Cooling PCW-HX-00007 A/B*
24590-LAW-M6-PCW-00002002	*P&ID - LAW Plant Cooling Water System Melters Power Supply Cooling PCW-PMP-00013A/B*
24590-LAW-M6-PCW-00002003	*P&ID - LAW Plant Cooling Water System Melters Power Supply Cooling MVE-PSUP-20001 & 2002*
24590-LAW-M6-PCW-00003001	*P&ID-LAW Plant Cooling Water System Melter 1 Cooling Water And Monitor PCW-HX-00004A/B*
24590-LAW-M6-PCW-00003002	*P&ID-LAW Plant Cooling Water System Melter 1 Cooling Water And Monitor PCW-PMP-00010A/B*
24590-LAW-M6-PCW-00004001	*P&ID-LAW Plant Cooling Water System Melter 2 Cooling Water And Monitor PCW-HX-00005A/B*
24590-LAW-M6-PCW-00004002	*P&ID-LAW Plant Cooling Water System Melter 2 Cooling Water And Monitor PCW-PMP-00011A/B*
24590-LAW-M6-PCW-00008001	*P&ID-LAW Plant Cooling Water System Pour Cave Cooling Panels PCW-HX-00019A/B*
Physical Layout Drawings	
24590-LAW-P1-P01T-00002	*LAW Vitrification Building General Arrangement Plan at EL. 3 Feet-0 Inches*

Document Number	Title
24590-LAW-P1-P01T-00003	*LAW Vitrification Building General Arrangement Plan at EL. 22 feet-0 inches*
24590-LAW-P1-P23T-00018	*LAW Vitrification Building Equipment Location Plan EL. 3'-0"/Area 11*
24590-LAW-P1-P01T-00001	*LAW Vitrification Building General Arrangement Plan at EL. (-)21'-0"*
System Descriptions	
24590-LAW-3ZD-20-00001	*System Design Description - LAW Ventilation Systems Design Description*
24590-LAW-3ZD-LFP-00001	*LAW Melter Feed Process (LFP) and Concentrate Receipt Process (LCP) System Design Description.*
24590-LAW-3ZD-LMH-00001	*LAW Melter Handling (LMH) System Design Description*
24590-LAW-3YD-LOP-00001	*System Description for the LAW Primary Offgas (LOP) and Secondary Offgas/Vessel Vent (LVP) Systems*
24590-LAW-3YD-LSH-00001	*System Description for the System LSH Melter Equipment Support Handling*
24590-WTP-3YD-PTJ-00001	*System Description for Process and Mechanical Handling CCTV System (PTJ)*

Appendix A Test Objectives, Conditions, and Acceptance Criteria

Requirement (para #)	Test (T) or Demo (D)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.4.1.1	D	Perform a demonstration to verify melter feed can be transferred from the LFP system to the melters at a feed rate that will support the feed rate to support the LMP commissioning demonstration capacity.	(TAC) (number (**TBD**)) of simulant batches of feed as successfully fed to the melter without the feed nozzles clogging, for a length of time of (**TBD**).		
3.4.1.2	T	Perform an integrated test to verify the combined output for the LAW melter system can produce a minimum of 18 MTG/day during cold commissioning over a 20 day period.	(GTC) Combined glass output for both LAW melters is 18 MTG/day over a 20 day period.	Performed per WTP Contract, DOE 2000, Section C, Standard 5	Cold Commissioning
3.4.1.2	T	Perform an integrated test to verify the combined output for the LAW melter system can produce a minimum of 18 MTG/day during hot commissioning over a 20 day period.	(GTC) Combined glass output for both LAW melters is 18 MTG/day over a 20 day period.	Performed per WTP Contract, DOE 2000, Section C, Standard 5	Hot Commisioning
3.4.1.3	T	Perform a test during commissioning to verify the joule heating system is capable of raising the melt pool to a nominal temperature of 1150 °C. Temperature Indicators (CTNs): Melter 1: LMP-TI-1263A/B/C through LMP-TI-1280A/B/C Melter 2: LMP-TI-2263A/B/C through LMP-TI-2280A/B/C	(TAC) The nominal temperature is maintained for 4 hours.	The average temperature will be taken across the thermocouples submerged in the melt pool. This demonstration will be done with frit only in the melt pool.	Non-hazardous Feed Testing , Cold Commissioning & Hot Commissioning LOP/LVP need to be operational Cooling water will be needed for cooling panels, Air will be needed for bubblers (0.1-3 scfm air @ 4-10 psig) All requirements of Sections III.10.H and III.10.C.2.1 of the DWP need to have been met. All instruments listed in DWP Table III.H.C need to be operational.
3.5.2.1	T	Perform testing to verify the annulus air pressure is at a vacuum relative to the melter gallery while the annulus air pressure is meeting the requirements of C5V system and the gallery air pressure is meeting the requirements of the C3V system. LMP-PDI-1412 /1413 melter 1 and LMP PDI-2412/2413 melter 2 measure the pressure difference between the annulus and the gallery for the PCJ system.	(TAC) The annulus air pressure is lower than the air pressure in the melter gallery (difference **TBD**). And The annulus air pressure is within an acceptable range for an area ventilated by C5V. And The melter gallery air pressure is with an acceptable range for an area ventilated by the C3V.	LMP-PDI-1412 /1413 melter 1 and LMP PDI-2412/2413 melter 2 measure the pressure difference between the annulus and the gallery for the PCJ system. These instruments are specified in DWP Permit Table IIII.10.H.C	TBD
3.5.2.1	T	Perform testing to verify the plenum pressure is at a vacuum relative to the annulus while the annulus air pressure is meeting the requirements of the C5V system. The acceptable pressure difference between the annulus and plenum is given in Section 3.3.B.2 of 24590-LAW-3PS-AE00-T0001, as -5.0 inWC. LMP-PDT/PDI -1410/1411, melter 1, LMP-PDT/PDI-2410/2411, melter 2 measure pressure difference between the plenum and the annular space for the PCJ system.	(TAC) The plenum air pressure is lower than the annulus are pressure (difference **TBD**). And The annulus air pressure is within an acceptable range for an area ventilated by C5V.		TBD

Requirement (para #)	Test (T) or Demo (D)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.5.2.2	D	Perform a demonstration during commissioning to verify the melt pool level will remain at a constant level of approximately 30 inches ± 2 inches for 4 hours while the melt pool is at the nominal temperature of 1100 °C while feeding and discharge operations are halted. Level Indicators – (CTNs): Melter 1: LMP-LI-1403, LMP-LI-1405 Melter 2: LMP-LI-2403, LMP-LI-2405	(TAC) The melt pool remains at a constant level of 30 inches ± 1.5 inches for 4 hours while the melt pool is at the nominal temperature of 1100 °C.	This is a test to verify that the jackbolts, cooling panels, and melter shell can contain the bulk glass. This demonstration will be done with frit only in the melt pool.	Non-hazardous Feed Testing & Cold Commissioning Cooling water will be needed for cooling panels, Air will be needed for bubblers (0.1-3 scfm air @ 4-10 psig) All requirements of Sections III.10.H and III.10.C.2.1 of the DWP need to have been met for Cold Commissioning. All instruments listed in DWP Table III.H.C need to be operational for Cold Commissioning.
3.6.2.4	T	Measure flow rate into the melter shell.	(TAC) Flow rate meets target flowrate determined by the final analysis (**TBD**)	The melter manufacturer estimated there will be a flowrate of 400 SCFM into the melter shell. Flow rate can be increased by increasing flow into the film coolers.	Cold Commissioning All equipment installed.
3.9.4.1, 3.15.4.1	D	Demonstrate the bubblers, thermal couples, level detectors, air lifts, startup heaters, jackbolts, and other components inside the melter enclosure can be accessed without compromising melter containment. Demonstrate bubbler assembly and level detectors change out.	(TAC) Demonstration performed with no recordable accidents.	This demonstration will be performed after the melt pool has been stable at 1150 °C (2100 °F) for a time to verify thermal expansion of the melter will not compromise maintenance operations.	Cold Commissioning Perform after the bubblers have been installed for a few weeks. C3V, C5V need to be operational. Melt pool will be at the nominal 30 inch level and at a nominal temperature of 1100 °C. Power to the electrodes is shut off. No cold cap. Cooling water will be needed for cooling panels, All requirements of Sections III.10.H and III.10.C.2.1 of the DWP need to have been met. All instruments listed in DWP Table III.H.C need to be operational.
3.14.1.2	T	Perform an integrated test to demonstrate the ability to monitor and control the output from the power supplies.	(GTC) The electrode power supplies can be remotely monitored and controlled and controlled. Specific test limits are **(TBD)**.		TBD
3.14.2.1.1	T	Perform a test to verify the PPJ does the following upon detection of high pressure (reduced vacuum) **(set point TBD)** in the melter plenum: • Terminates melter feed to the affected melter by simultaneously isolating air (LFP-YC-1208A/B/2208A/B) and water supplies (LFP-YC-1207A/B/2207A/B) to the LFP melter feed ADS pumps. • Stops air injection to the LVP film coolers (LOP-YC-1129/2129) • Stops process air to the LVP WESP (LOP-YC-1098/2098) • Stops demineralized water to the LVP film coolers (LOP-YC-1109/2109) • Opens isolation valves on the LOP standby offgas line (LOP-YC-1008A/B/2008A/B)	(TAC) The required operations are automatically performed upon the input of a high pressure signal in a melter plenum PPJ pressure transmitter.	Tests closing of valves on high pressure signal from: LMP-PDT/PDI- 1528/1529/2528/2529. The PPJ, LMP, LFP, LVP, and LOP systems are required to be operational to perform this test.	Non-hazardous Feed Testing LOP/LVP operational.

Requirement (para #)	Test (T) or Demo (D)	Plan (including SSCs)	Acceptance Criteria (TAC or GTC)**	Notes/Comments	Test Conditions
3.14.2.1.2	T	Perform a test to verify the capability to terminate transfer from MFVs to the melters, using the PPJ, when high temperature **(set point TBD)** is reached in the melter lid cooling cavity: Temperature Transmitters– (CTNs): Melter 1: LMP -TT -1637, LMP-TT-1638 Melter 2: LMP -TT-2637, LMP -TT-2638	**(TAC)** The required operations are automatically performed upon the input of a high temperature signal in a melter lid cooling cavity PPJ temperature transducer.	Test closing of valves LFP-YV-1207, 1208 (melter 1) and LFP-YV-2207, 2208 (melter 2) on high temperature signal from LMP-TE- 1637/1638 (melter 1) and LMP-TE-2637/2638 (melter 2). The PPJ, LMP, and LFP systems are required to be operational to perform this test.	Non-hazardous Feed Testing LFP, LOP/LVP operational
3.14.2.4.8	D	Demonstrate control of the movement of glass from the melt pool to the discharge chamber. Control Valves –(CTNs): Melter 1: LMP-YV-1047, LMP-YC-1047, LMP-YV-1125, LMP-YC-1125 Melter 2: LMP-YV-2047, LMP-YC-2047, LMP-YV-2125, LMP-YC-2125	**(TAC)** Demonstration performed		Startup All equipment installed
3.14.3.1	A/I/T	Verify air cooling is provided to the outside of the ILAW containers. Determine necessary temperatures and flow rates from pilot tests and tests during commissioning to determine the best flow rate and positioning for the air cooling nozzle.	**(GTC)** The nozzle locations and air flowrate values are determined that will provide sufficient cooling of the outside of the container to allow for an acceptable image of the glass inside the container to be picked up by the infrared camera.		Cold commissioning
3.14.3.2	D	Demonstrate the placement of the pour spout cameras can effectively be used to monitor glass pouring through the PTJ system.	**(GTC)** CCTV can effectively monitor glass pouring.		
3.14.2.4.9	D	Demonstrate the container level can be determined from the facility control room. Level Indicators and Transmitters –(CTNs): Melter 1: LMP-LE-1466, LMP-LT-1466, LMP-LI-1466B, LMP-LE-1511, LMP-LT-1511, LMP-LI-1511B Melter 2: LMP-LE-2466, LMP-LT-2466, LMP-LI-2466B, LMP-LE-2511, LMP-LT-2511, LMP-LI-2511B	**(TAC)** Demonstration performed	This test should be accomplished with the use of the infrared cameras Instruments LMP-LE-1466, LMP-LT-1466, LMP-LI-1466B, LMP-LE-1511, LMP-LT-1511, LMP-LI-1511B, LMP-LE-2466, LMP-LT-2466, LMP-LI-2466B LMP-LE-1466 are specified in DWP Permit Table IIII.10.H.C	Non-hazardous Feed Testing
3.15.3.5	T	Verify the melter electrode power supplies, as well as busses between the melter electrode power supplies and melters, remain ungrounded when the system is energized.	**(TAC)** Melter electrode power supplies and associated busses remain ungrounded during normal operating conditions.		TBD

Any nonsafety related anomalies or issues experienced during the execution of a test or demonstration plan to validate a requirement can be put on **[HOLD]** until the issue has been resolved.

Notes:

* This test/demonstration is planned for completion by Startup.

** Test acceptance criteria (TAC) are based on requirements from authorization basis documents. General test criteria (GTC) are requirements from other sources.

Any nonsafety related anomalies or issues experienced during the execution of a test or demonstration plan to validate a requirement can be put on **[HOLD]** until the issue has been resolved.

Appendix B Description of Functional Flow and Interactions

Function: A.1	***Receive Feed Slurry***
Detailed description: The melter feed nozzles receive feed delivered from the LFP ADS pumps. The feed nozzles are designed to prevent plugging nozzles to ensure operability.	
Initiation: This function initiates when an operator determines the melter is conditioned to receive feed.	
Termination: This function terminates when an operator determines the melter is not conditioned to receive feed or the melter is being readied for standby mode.	
Parallel or sequential functions: All	
Applicable Modes: Normal operations	

Function: A.2	***Melt Pool Temperature, Glass Production***
Detailed description: Maintain the melt pool temperature in the range of 1050 °C to 1200 °C, (1922 °F to 2192 °F).	
Initiation: This process initiates after the main power to the electrodes have been initiated (G.1) and the melt pool has time to warm up.	
Termination: This process terminate after the main power to the electrodes have been terminated (G.1) and the melt pool has time to cool down.	
Parallel or sequential functions: All	
Applicable Modes: Operation	

Function: A.3	***Melting and Agitation, Glass Production***
Detailed description: As the joule heating warms the cold cap deposited on the surface of the melt pool, the cold cap will melt into the melt pool while volatiles are released to the plenum. Bubblers located at three different levels of the melt pool promote the mixing and thus the melting of the cold cap by agitating the melted pool with forced air.	
Initiation: This process initiates when operators set the valve line-ups to provide ISA to the bubblers.	
Termination: This process terminates when the operators set the valve line ups to shut down ISA to the bubblers.	
Parallel or sequential functions: All	
Applicable Modes: Operation	

Function: A.4	***Maintain Melt Pool Level, Glass Production.***
Detailed description: The level of the molten glass in the melt pool will remain relatively constant, not varying more than about thirty inches. Operators will coordinate melter feeding and glass discharge to maintain the melt pool level.	
Initiation: This process initiates when operators balance the amount of melter feed intake with the amount of glass discharged from the melter.	
Termination: This process terminates when the associated LAW melter is taken out of service	
Parallel or sequential functions: All	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: A.5	***Maintain Plenum Temperature, Glass Production***
Detailed description: The plenum temperature is an indication of the changing characteristics of the cold cap. For example, a low plenum temperature is a likely indication of an excessive about of foam on the cold cap. In this situation, the operators can take action to change the chemistry of the melter feed to reduce foaming and increase the plenum temperature.	
Initiation: This process initiates when operators balance the melter feed operation (A1)with the readings of the ongoing properties of the plenum.	
Termination: This process terminates when the process A1 terminates.	
Parallel or sequential functions: ALL	
Applicable Modes: Operation	

Function: A.6, A.6.1, A.6.2	***Maintain Cascading Ventilation***
Detailed description: The cascading ventilation system forces offgas out through the LOP system and restricts offgas from seeping into the melter gallery. The pressure drops from the melter gallery (C3 area) to the annulus (C5 area), to the plenum (the plenum pressure is controlled by the LOP system).	
Initiation: This process initiates when the LOP and LVP systems are fully installed and running, and the C5V system is ventilating the melter annulus and the C3V system is ventilating the melter gallery.	
Termination: This process terminates when the associated LAW melter is taken out of service or there is an in balance between the LOP, LVP, C3V and C5V systems.	
Parallel or sequential functions: All	
Applicable Modes: Initial Configuration, Operation	

Function: A.7	***Lift Molten Glass to the Discharge Chamber, Glass Production***
Detailed description: When operators determine the melt pool is at the proper level, operators will activate an air lift lance to lift batches of molten glass out of the melt pool and into the discharge chamber. From the discharge chamber, the glass will be poured through the pour spout, into a container.	
Initiation: This process initiates when the melter operators determine the melt pool is at a proper level for discharge. Being a batch process, discharge will start and stop as the air lift is refilled with glass and dispenses the glass.	
Termination: This process will terminate when the melter operators determine the container is filled.	
Parallel or sequential functions: All	
Applicable Modes: Operation	

Function: A.8	***Heat Discharge Chambers***
Detailed description: Maintain discharge chambers at a temperature which the glass remains molten.	
Initiation: This process initiates when the discharge chamber heaters are turned on as the melt pool is initially brought up to its operating temperature.	
Termination: This process will terminate when the discharge chamber heaters are shut down, at the end of operations for the associated melter, or with the loss of normal plant power.	
Parallel or sequential functions: Any or all other functions	
Applicable Modes: Operation	

Function: A.9	***Discharge Glass to ILAW container, Glass Production***
Detailed description: Discharge glass from the discharge chamber into the ILAW container.	
Initiation: This process will initiate when function (A7) lifts the glass to the top of the trough in the discharge chamber, being a batch process, discharge will start and stop as the air lift is refiled with glass and dispenses the glass.	
Termination. This process will terminate when the last batch of glass is delivered from the air lift riser.	
Parallel or sequential functions: All	
Applicable Modes: Operation	

Function: B.1	***Argon Gas Purge***
Detailed description: Argon will trickle continuously to the level and density probes and air lift lances to reduce oxidation and foaming.	
Initiation: This process will initiate when all valves between the MXG and LMP systems are lined up to allow argon gas to trickle to the density probes and air lifts. This valve line up will be established at the beginning of startup testing. .	
Termination: This process terminates when valves between the MXG and LMP systems are lined up to halt the trickle of argon to the instruments. This valve line up will occur when the melter is taken out of service.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: B.2	***Engineered In-Leakage***
Detailed description: Engineered forms of in-leakage to purge corrosive gases away from melter structures and components .Most of this in-leakage will come from air delivered to the film cooler.	
Initiation: This process initiates when the LOP and LVP systems are fully installed and running, and the C5V system is ventilating the melter annulus.	
Termination: This process terminates when the associated LAW melter is taken out of service.	
Parallel or sequential functions: All	
Applicable Modes: Operation	

Function: C.1	***Air Cooling of CCTV Cameras***
Detailed description: ISA air is used to cool the outside of CCTV cameras mounted on the seal head. The outside of the cameras are in a C3V area.	
Initiation: This process initiates when the valve line up is set to allow ISA air to flow to the cameras. This process should be initiated before glass pouring begins.	
Termination: This process terminates when the valve line up is set to prohibit ISA air to flow to the cameras.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Operation, Standby	

Function: C.2	***Air Knives Around Container.***
Detailed description: During pouring operations, air from the PSA system is streamed over the container to cool the outside of the container in the vicinity of the IR camera viewing area to enhance the image. Shine from hot glass to the container wall can interfere with a good image during a pour. Air from the air knives reduces this interference.	
Initiation: This process initiates when the valve line up is set to allow PSA air to flow to the air knives. This process should be initiated before glass pouring begins.	
Termination: This process terminates when the valve line up is set to prohibit PSA air to flow to the air knives.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Operation	

Function: D.1	***Isolate Melter Cooling Water Across Heat Exchanger***
Detailed description: Each melter will have its own closed cooling water loop. This main melter cooling water loop will run at the PCW pressure and cool by passing through a heat exchanger with water from the main PCW circuit.	
Initiation: There is no initiation for the isolation process. The design provides for melter cooling water to be provided only from one side of heat exchangers with the main PCW system. The circulation process through the LMP system initiates when pumps PCW-PMP-00010A/B(Melter 1) and PCW-PMP00011A/B(Melter 2) are started.	
Termination: There is no termination for the isolation process. The design provides for melter cooling water to be provided only from one side of heat exchangers with the main PCW system. The circulation process through the LMP system terminates when pumps PCW-PMP-00010A/B (Melter 1) and PCW-PMP00011A/B (Melter 2) are shut down.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: E.1	***Cooling Panels For Melt Pool, Discharge Chambers***
Detailed description: Cooling water will circulate through cooling panels surrounding the melt pool, pour seal head, and discharge chamber as part of the system to contain the bulk glass.	
Initiation: This function initiates when the valve line up is set to allow cooling water to flow into the cooling panels.	
Termination: This function terminates when the valve line up is set to prohibit cooling water to flow into the cooling panels.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: E.2	***Cooling for Feed Nozzles***
Detailed description: Cooling water will circulate through the feed nozzles to protect the feed from drying out and plugging the feed nozzle.	
Initiation: This function initiates when the valve line up is set to allow cooling water to flow through the feed nozzles..	
Termination: This function terminates when the valve line up is set to prohibit cooling water from flowing through the feed nozzles.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: E.3	***Cooling Plenum, Offgas, and Shield Lid.***
Detailed description: Cooling water will circulate through panels to cool the plenum, offgas ports (the film cooler), and the top of the shield lid. Plenum and offgas temperature control is critical to maintain the offgas system. The shield lid must be cooled to allow worker access there for consumable change outs and other maintenance.	
Initiation: This function initiates when the valve line up is set to allow cooling water to flow into the cooling panels.	
Termination: This function terminates when the valve line up is set to prohibit cooling water to flow into the cooling panels.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: E.4, E.4.1	***Cooling the Melter Lid Cooling Cavity***
Detailed description: Cooling water will circulate through baffles above the gas barrier lid plate to cool the gas barrier lid. Unlike other cooling water in LMP, the sub circuit for the gas barrier lid cooling will run at atmospheric pressure. The water in this circuit will cool by passing through a heat exchanger with the water from the main melter cooling circuit. The water is maintained at atmospheric pressure by passing through a vented tank.	
Initiation: This function initiates when the valve line up allows for the cooling water to flow into the melter lid cooling cavity loop and pumps LMP-PMP-00001/2 (Melter 1) and LMP-PMP-00003/4(Melter 2) are started.	
Termination: This function terminates when the valve line is changed to prohibit cooling water flow into the melter lid cooling cavity loop and pumps LMP-PMP-00001/2 (Melter 1) and LMP-PMP-00003/4(Melter 2) are shut down..	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operation, Standby	

Function: F.1	***Drain to the RLD***
Detailed description: In the case of a cooling panel rupture, the cooling water will drain to the RLD. Leak detectors in the annular space and inside the gas barrier as well as cooling water flow indicators will alert operators to the problem. The water must be able to drain away from the melt pool because too much water in the melt pool could generate enough steam to affect the offgas system.	
Initiation: This process initiates only if there is a breech in the melter cooling water system.	
Termination: This process terminates when the leak is addressed by operations.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Off Normal Operations	

Function: G.1	***Provide Power to the Electrodes***
Detailed description: Provide power to the electrodes for joule heating.	
Initiation: This process initiates when the main power supplies to the electrodes are turned on from the control room.	
Termination: This process ends when the main power supplies to the electrodes are shut down from the control room, or during a loss of normal power.	
Parallel or sequential functions: All	
Applicable Modes: Initial Configuration, Operations, Off Normal Operations	

Function: H.1	***PCJ-Normal Controls to Support Monitoring, Control, and Communication***
Detailed description: Non-safety monitoring and control functions are supported by the PCJ. Components that are controlled automatically by the PPJ are also monitored by the PCJ during normal operations. The functions that are monitored and controlled by the PCJ are: • Control melt pool temperature by adjusting power to the electrode power supply. • Monitor and control temperature in the melt pool by shutting off ADS pumps if temperature is too high or too low. • Set hand switches for high/low melt pool temperatures. • Monitor pressure difference between the annular space and melter gallery. • Monitor pressure difference between the plenum and the annular space. • Monitor and control temperature in the plenum by shutting down feed if plenum temperature is too low. • Set hand switches for high plenum pressure. • Set hand switches for high/low plenum temperature. • Monitor container fill level, control from over filling with interlock. • Monitor melt pool level. • Monitor melt pool density. • Monitor temperature, airflow and pressure for electrode extension cooling • Monitor refractory temperature. • Monitor flow and temperature of cooling water to melt pool and discharge chamber cooling panels. • Monitor flow and temperature for plenum wall cooling panels. • Monitor flow and temperature for film coolers cooling panels. • Monitor for leak detection in the feed encasement assembly. • Control flow, pressure and level for air lifts to the discharge chambers. • Monitor for annulus leak detection • Monitor for gas barrier leak detection. • Monitor flow, temperature and alarm for HI temperature in cooling water for the melter lid cooling cavity. • Monitor flow and temperature in the melter lid cooling cavity heat exchanger. • Monitor level in the melter lid cooling cavity tank. • Monitor flow and temperature of cooling water to feed nozzles. • Monitor temperatures in the discharge chamber. • Monitor and control discharge heaters (LVE) power, temperatures • Monitor flow and pressure of air to the bubblers • Control startup heaters' power, temperature. • Monitor and control power supplies for electrodes. • Monitor and control startup heater ramp.	
Initiation: These processes initiate when the transmitters for each function are connected to the PCJ system.	
Termination: These processes will run continually throughout the life of a melter and terminate only when the associated melter is permanently shut down.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operations, Standby, Off-normal Operations, Not credited for design basis events	

Function: H.2	***PPJ – Safety Instrumented Functions and Alarms to Support Monitoring, Control, and Communication***
Detailed description: Automated safety monitoring and control functions are supported by the PPJ. The functions that are monitored and controlled by the PPJ are: • Upon detection of the plenum pressure being high, a PPJ function closes a valve supplying air to the melter ADS pumps. • Upon detection of the plenum pressure being high, a PPJ function closes a valve supplying DIW to the melter ADS pumps. • Upon detection of the plenum pressure being high, a PPJ function closes a valve supplying water to the film cooler. • Upon detection of the plenum pressure being high, a PPJ function opens the standby offgas line. • Upon detection of the plenum pressure being high, a PPJ function closes the valve supplying Air to the WESP. • Upon detection of the plenum pressure being high, a PPJ function terminates air and demineralized water to the film cooler. • Upon detection of high temperatures in the melter lid cooling water cavity, a PPJ function shuts down the feeds to both melters.	
Initiation: This process initiates when the pressure transducers detect a high pressure in the plenum or high temperature in the melter lid cooling cavity.	
Termination: This process will terminate when the upset condition no longer exists and the instruments are manually reset.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Initial Configuration, Operations, Standby, Off-normal Operations	

Function: H.3	***PTJ- Process and Mechanical Handling CCTV System***
Detailed description: Images form CCTV and IR cameras as well as container level data from the IR camera are transmitted through the PTJ system.	
Initiation: This process initiates when the control room operator sends the initiating command.	
Termination: This process terminates when the camera is shut down from the control room.	
Parallel or sequential functions: This function can run independently or with any and all other functions.	
Applicable Modes: Operations	

Appendix C Active Safety Instruments and Functions

The listed instruments are designated as having active safety functions, implemented through interface with and programming in the PPJ system. Information in the table below reflects the current design of active safety instruments, including functions, and safety designations per the P&IDs and associated equipment and instrument lists. In some cases the current safety classification of the SSCs in design is known to exceed the design requirements. The information will be updated as needed to reflect changes to the design. The information below is provided in support of Plant Engineering and Operations and does not represent design requirements.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 1 Plenum Pressure	NA	LMP -PDT -1528 LMP -PDT -1529	LVP -PV -0072 via LVP -PY -0072B and LVP -YC -0072, LVP -YV -0528 via LVP -YC -0528, LVP -YV -0538 via LVP -YC -0538	Upon detection of plenum pressure being high, the function closes valves supplying ammonia and dilution air as well as closing the Vessel Vent Header Pressure Control Valve.
Melter 2 Plenum Pressure	NA	LMP -PDT -2528 LMP -PDT -2529	LVP -PV -0072 via LVP -PY -0072B and LVP -YC -0072, LVP -YV -0528 via LVP -YC -0528, LVP -YV -0538 via LVP -YC -0538	Upon detection of plenum pressure being high, the function closes valves supplying ammonia and dilution air as well as closing the Vessel Vent Header Pressure Control Valve.
Melter 1 Plenum Pressure - ADS Pump Air Isolation	SS	LMP -PDT -1528 LMP -PDT -1529	LFP -YV -1208 via LFP -YC -1208B	Upon detection of the plenum pressure being high, the function closes a valve supplying air to the melter ADS pumps.
Melter 2 Plenum Pressure - ADS Pump Air Isolation	SS	LMP -PDT -2528 LMP -PDT -2529	LFP -YV -2208 via LFP -YC -2208B	Upon detection of the plenum pressure being high, the function closes a valve supplying air to the melter ADS pumps.
Melter 1 Plenum Pressure - ADS Pump Water Isolation	SS	LMP -PDT -1528 LMP -PDT -1529	LFP -YV -1207 via LFP -YC -1207B	Upon detection of the plenum pressure being high, the function closes a valve supplying DIW to the melter ADS pumps.
Melter 2 Plenum Pressure - ADS Pump Water Isolation	SS	LMP -PDT -2528 LMP -PDT -2529	LFP -YV -2207 via LFP -YC -2207B	Upon detection of the plenum pressure being high, the function closes a valve supplying DIW to the melter ADS pumps.
Melter 1 Plenum Pressure - Film Cooler Air Supply Isolation	SS	LMP -PDT -1528 LMP -PDT -1529	LOP -YV -1129 via LOP -YC -1129	Upon detection of the plenum pressure being high, the function closes a valve supplying air to the film cooler.

Function Title	Safety Designation	Sensors	Final Control Elements	Functional Description
Melter 2 Plenum Pressure - Film Cooler Air Supply Isolation	SS	LMP -PDT -2528 LMP -PDT -2529	LOP -YV -2129 via LOP -YC -2129	Upon detection of the plenum pressure being high, the function closes a valve supplying air to the film cooler.
Melter 1 Plenum Pressure - Film Cooler Water Supply Isolation	SS	LMP -PDT -1528 LMP -PDT -1529	LOP -YV -1109 via LOP -YC -1109	Upon detection of the plenum pressure being high, the function closes a valve supplying water to the film cooler.
Melter 2 Plenum Pressure - Film Cooler Water Supply Isolation	SS	LMP -PDT -2528 LMP -PDT -2529	LOP -YV -2109 via LOP -YC -2109	Upon detection of the plenum pressure being high, the function closes a valve supplying water to the film cooler.
Melter 1 Plenum Pressure - Standby Offgas Line	SS	LMP -PDT -1528 LMP -PDT -1529	LOP -YV -1008 via LOP -YC -1008B	Upon detection of the plenum pressure being high, the function opens the standby offgas line.
Melter 2 Plenum Pressure - Standby Offgas Line	SS	LMP -PDT -2528 LMP -PDT -2529	LOP -YV -2008 via LOP -YC -2008B	Upon detection of the plenum pressure being high, the function opens the standby offgas line.
Melter 1 Plenum Pressure - WESP Air Isolation	SS	LMP -PDT -1528 LMP -PDT -1529	LOP -YV -1098 via LOP -YC -1098	Upon detection of the plenum pressure being high, the function closes the valve supplying Air to the WESP.
Melter 2 Plenum Pressure - WESP Air Isolation	SS	LMP -PDT -2528 LMP -PDT -2529	LOP -YV -2098 via LOP -YC -2098	Upon detection of the plenum pressure being high, the function closes the valve supplying Air to the WESP.
Melter 1 Lid Cooling Cavity High Temperature Interlock	SS	LMP -TT -1637 LMP -TT -1638	LFP -YV -1207 via LFP -YC -1207B, LFP -YV -1208 via LFP -YC -1208B, LFP -YV -2207 via LFP -YC -2207B, LFP -YV -2208 via LFP -YC -2208B	High temperatures in the melter lid cooling water cavity shut down the feeds to both melters.
Melter 2 Lid Cooling Cavity High Temperature Interlock	SS	LMP -TT -2637 LMP -TT -2638	LFP -YV -1207 via LFP -YC -1207B, LFP -YV -1208 via LFP -YC -1208B, LFP -YV -2207 via LFP -YC -2207B, LFP -YV -2208 via LFP -YC -2208B	High temperatures in the melter lid cooling water cavity shut down the feeds to both melters.

Appendix D System Procedures

Reserved

Appendix E System History

Reserved

Attachment 2
15-ECD-0060
(2 Pages)

U.S. Department of Energy, Office of River Protection and
Bechtel National, Inc. Certification Statements

U.S. Department of Energy, Office of River Protection Certification

The following certification statement is provided for the submittal of the Hanford Facility Resource Conservation and Recovery Act Permit Modification Notification LAW-016 Engineering Documentation.

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.

K. W. Smith, Manager
U.S. Department of Energy,
Office of River Protection

12/17/15
Date

Bechtel National, Inc. Certification

The following certification statement is provided consistent with Contract No. DE-AC27-01RV14136, Section H.26, Environmental Permits, paragraph (g) for the submittal of the Hanford Facility Resource Conservation and Recovery Act Permit Package LAW-016 Engineering Documentation.

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.

M. G. McCullough
Project Director

OXENFORD Acting FOR MGM

12/15/15
Date