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TITLE: Environmental Restoration
Disposal Facility (ERDF)
Cells 7-10 Detailed Design
Package, Rev. 0

SPECIFICATION FOR

COATINGS & FINISHES

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF) CELLS 7, 8, 9 & 10 CONSTRUCTION

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COATINGS AND FINISHES

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for Coatings and Finishes.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meaning:

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
FS	Federal Specifications
MSDS	Material Safety Data Sheet
QAP	Quality Assurance Program
SSPC	Steel Structures Painting Council
SSRS	Subcontractor/Supplier Submittal Requirements Summary
VOC	Volatile Organic Compound

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Coatings and Finishes. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Coatings and Finishes. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ACGIH	Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices
FS TT-E-489	Enamel, Alkyd, Gloss, Low VOC Content
FS TT-E-508	Enamel, Interior Semigloss, Tints and White
FS TT-E-509	Enamel, Odorless, Alkyd, Interior, Semigloss, White and Tints
FS TT-P-96D	Paint, Latex Base, For Exterior Surfaces, Whites and Tints
FS TT-P-645B	Primer, Paint, Zinc-Molybdate, Alkyd Type

SSPC-SP 1	Solvent Cleaning
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 3	Power Tool Cleaning
SSPC-SP 7	Brush-Off Blast Cleaning
ANSI A13.1	American National Standard Scheme for the Identification of Piping Systems

1.4 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I," Subcontractor/Supplier Submittal Requirements Summary (SSRS) Submittals that do not meet requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays

1.4.1 Identification Tags

Provide a list of tags (valves, buildings, etc.) prior to fabrication. A sample of each size and style tag shall be provided with the list.

1.4.2 Samples

Submit samples of the identification devices to be used in the work.

1.5 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show:

- designated name
- formula or specification number
- batch number
- color
- quantity
- date of manufacture
- manufacturer's formulation number
- manufacturer's directions including any warnings and special precautions, and name of manufacturer.

Pigmented paints shall be furnished in containers not larger than 20 liters (5 gallons). Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 4 and 35 degrees C (40 and 95 degrees F). Paints

shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.6 APPROVAL OF COATING MATERIALS

Materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the CONTRACTOR for testing should the materials appear defective during or after application. In addition to any other remedies under the Subcontract the cost of testing defective materials will be at the SUBCONTRACTOR's expense.

1.7 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 7 and 35 degrees C (45 and 95 degrees F) when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings. Water-thinned coatings shall be applied only when ambient temperature is between 10 and 32 degrees C (50 and 90 degrees F). Epoxy shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer.

1.8 SAFETY AND HEALTH

Work shall comply with applicable Federal laws and regulations, and with the SUBCONTRACTORS Safety and Health Plan. The Safety and Health Plan shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.8.1 Worker Exposures

Exposure of workers to chemical substances shall not exceed limits as established by American Conference of Governmental Industrial Hygienists (ACGIH), threshold limit values (TLV) for chemical substances and physical agents and biological exposure indices (BEI) or as required by a more stringent applicable regulation.

1.8.2 Toxic Compounds

Toxic compounds having ineffective physiological properties, such as odor or irritation levels, shall not be used unless approved by the CONTRACTOR.

1.8.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material safety data sheets (MSDS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one that may receive mists and odors from the painting operations. Workers

involved in preparation, painting and clean-up shall be trained in the safe handling, application, and the exposure limit, for each material that will be used in the project. Personnel having a need to use respirators and masks shall be instructed and trained in the use and maintenance of such equipment.

1.8.4 Coordination

Work shall be coordinated to minimize exposure of other SUBCONTRACTOR personnel and visitors to mists and odors from preparation; painting and clean-up operations.

2.0 MATERIALS AND EQUIPMENT

2.1 PAINT

The term "paint" as used herein includes enamels, paints, epoxy, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the respective specifications listed for use in the painting schedules at the end of this section.

2.1.1 Colors and Tints

Colors shall be as selected by the CONTRACTOR from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of paints shall be done by the manufacturer. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.3 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.4 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

2.1.5 Epoxy

Amerlock 400, or approved equal, manufactured by Ameron.

3.0 IDENTIFICATION OF PIPING

3.1 GENERAL

Identification of exposed pipes shall be accomplished by color-coding with bands and by lettering as specified in this specification. Color bands shall either be painted directly upon the pipe or shall be pressure-sensitive adhesive-backed vinyl cloth or plastic tape.

3.1.1 Labels

Each pipe identification shall consist of 2 color-coded bands, a printed label identifying the name of the pipe, and a flow arrow to indicate direction of flow in the pipe. Labels shall be preprinted on pressure-sensitive adhesive-backed vinyl cloth or plastic tape. Arrows shall be die-cut of the same type of material as the labels. Labels shall be placed on the outside of insulated piping systems.

3.1.2 Lettering

Letter sizes and colors for lettering, arrows, and background shall conform to ANSI A13.1.

3.2 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

3.2.1 General

Identifying devices for valves and the sections of pipe that are too short to be identified with color bands, lettered labels, and arrows shall be identified with metal tags as specified herein.

3.2.2 Tags

Metal tags shall be 16-gauge Type 304 stainless steel metal strips $\frac{3}{4}$ inch wide with $\frac{3}{16}$ -inch high letters stamped on the metal surface. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes. Tags shall not interfere with equipment operations (i.e. valves, pumps, etc.)

4.0 EXECUTION

4.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

4.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed with clean cloths and cleaning solvents prior to mechanical cleaning. Cleaning solvents shall be of low toxicity with a flashpoint in excess of 38 degrees C (100 degrees F). Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

4.2.1 Concrete Surfaces

Concrete surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacture's recommended conditioner prior to application of the first coat.

4.2.2 Ferrous Surfaces

Ferrous surfaces, including those that have been shop-coated, shall be solvent-cleaned. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC-SP 2, power tools according to SSPC-SP 3 or by sandblasting according to SSPC-SP 7. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

4.2.3 Nonferrous Metallic Surfaces

Where nonferrous metal surfaces are to be painted, they shall be solvent-cleaned in accordance with SSPC-SP 1.

4.2.4 Plywood Surfaces

Plywood surfaces shall be dry and shall have loose dirt and dust removed by brushing with a soft brush, rubbing with a cloth, or vacuum cleaning prior to application of the first-coat material.

4.3 MIXING AND THINNING

Paints may be thinned in accordance with the manufacturer's directions. The use of thinner shall not relieve the SUBCONTRACTOR from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed local limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

4.3.1 Two-Component Systems

Two-component systems shall be mixed in accordance with manufacturer's instructions. Any thinning of the first coat to ensure proper penetration and sealing shall be as recommended by the manufacturer for each type of substrate.

4.4 APPLICATION

Painting practices shall comply with applicable state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

4.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH, or as required by a more stringent applicable regulation.

4.4.2 Respirators

Use of respirators shall be directly related to the product used. Final determination as to whether or not respirators must be used will be made by the SUBCONTRACTOR and will be dependent on the toxicity, method of application, and the SUBCONTRACTORS safety plan, job hazard analysis, risk rank analysis, and work package.

4.4.3 First Coat

The first coat on plywood shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application.

4.4.4 Timing

Surfaces that have been cleaned, pre-treated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between

successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

4.4.5 Fillers

Concrete surface voids shall be filled with filler material recommended by the paint manufacturer; however, surface irregularities need not be completely filled. The dried filler shall be uniform and free of pinholes. Filler shall not be applied over caulking compound.

4.4.6 Ferrous-Metal Primer

Primer for ferrous-metal shall be applied to ferrous surfaces to receive paint other than asphalt varnish prior to deterioration of the prepared surface. The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

4.5 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted as scheduled.

4.6 SURFACES NOT TO BE PAINTED

Surfaces of hardware, fittings, and other factory finished items shall not be painted.

4.7 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

4.8 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. SUBCONTRACTOR options are indicated by ---or--- between optional systems or coats.

INTERIOR PAINTING SCHEDULE

<u>Surface</u>	<u>System No.</u>	<u>First Coat</u>	<u>Second Coat</u>	<u>Third Coat</u>
Concrete, floors, pads and curb in Crest Pad Building Meter room	PS-6	Amerlock 400 or equal @ 5-8 mils dry	Amerlock 400 or equal @ 5-8 mils dry	None
Interior wall Surfaces	PS-2	FS TT-P-25E @ 1.6 mil dry	FS TT-P-96 @ 1.6 mil dry	FS TT-P-96 @ 1.6 mil dry
Ferrous metal factory- primed mechanical and electrical equipment	PS-5	FS TT-E-489 @ 2.5 mil dry	FS TT-E-489 @ 2.5 mil dry	None
Ferrous metal	PS-5	FS TT-P-645 @ 2.5 mil dry	FS TT-E-508 ----or---- FS TT-E-509 @ 2.5 mil dry	

4.9 IDENTIFICATION DEVICES

The SUBCONTRACTOR shall furnish, mark, and install identification devices for exposed piping and valves using color bands, lettering, flow direction arrows, and related permanent identification devices, and appurtenant works, in accordance with the requirements of the Subcontract Documents. Labels and identification tags shall be installed in accordance with the manufacturers printed instructions, and shall be neat and uniform in appearance. Tags or labels shall be readily visible from normal working locations.

4.9.1 Valve Tags

Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

The wording on the valve tags shall describe the exact function of each valve, e.g., LE - Tank 1 shut-off.

4.9.2 Pipe Identification

Each pipe shall be identified at intervals of 20 feet, and at least one time in each room. Piping shall also be identified at a point approximately within 2 feet of turns, ells, valves, and on the upstream side of distribution fittings or branches. Sections of pipe that are too short to be identified with color bands, lettered labels, and directional arrows shall be tagged and identified similar to valves.

Pipe identification shall consist of 4 elements, i.e., 2 color bands, a lettered label, and a directional label. The bands shall be arranged so that the lettered label and the directional arrow are placed between the 2 bands.

4.9.3 Identification Schedule

Application of identifying devices shall conform to the following color codes.

Fluid Abbreviation	Function and Identification	Identification Color
LE	Leachate	Yellow/Magenta

4.10 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR, or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall submit to CONTRACTOR records of quality control for operations including but not limited to the following:

- (1) Delivery, storage, and handling of devices and equipment used.
- (2) Conformance of materials to the requirements of these specifications.
- (3) Inspection of devices and equipment installed.
- (4) Field testing of devices and equipment.
- (5) Installation of devices and equipment to these requirements and applicable codes and standards.

Records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be submitted to the CONTRACTOR in accordance with Exhibit "I".

**SPECIFICATION
FOR
CIVIL SURVEYING SERVICES
AT
HANFORD SITE**



EXPIRES: 4-21-09

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SPECIFICATION FOR CIVIL SURVEYING SERVICES

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CODES, STANDARDS, DEFINITIONS, AND ABBREVIATIONS

This technical specification establishes the quality of materials and workmanship and defines how quality is measured for civil surveying services. All surveying services defined herein may not be required. Only those activities and submittals required in the applicable work release, scope of work, design drawings, and Subcontractor Submittal Requirements Summary (SSRS) for specific services shall apply.

1.1 CODES AND STANDARDS

To conform to surveying standards and specifications, all dimensions and specifications will be given in metric units.

Unless otherwise specified or shown on the drawing, material, office work, and field surveys shall conform to the latest issue of the following codes and standards and shall apply to the extent indicated herein.

1.1.1 Federal Geodetic Control Committee (FGCC)

Standards and Specifications for Geodetic Control Network-FGCC, Rockville, Maryland, 1984.

1.1.2 Washington Administrative Code (WAC)

- WAC 196: Professional Engineers and Land Surveyors, Board of Registration for,
- WAC 332-130: Minimum Standards for Land Boundary Surveys and Geodetic Control Surveys and Guidelines for the Preparation of Land Descriptions.

1.1.3 Federal Regulations and Guidance

- CERCLA/Superfund Amendments and Reauthorization Act
- A Compendium of Superfund Field Operations Method.

1.1.4 Occupational Safety and Health Administration (OSHA)

- 29 CFR 1910-120: Hazardous Waste Operations and Emergency Response.

1.2 ABBREVIATIONS

The abbreviations listed below, where used in this specification, shall have the following meanings:

- mm: millimeter(s)
- cm: centimeter(s)
- m: meter(s)

- WAC: Washington Administrative Code
- FGCC: Federal Geodetic Control Committee
- NTP: Notice to Proceed
- SSRS: Subcontractor Submittal Requirements Summary
- OSHA: Occupational, Safety and Health Administration
- CERCLA: Comprehensive, Environmental, Recovery, Compensation, and Liability Act
- NAD83 (1991): North American Datum of 1983, adjusted in 1991
- NAVD88: North American Vertical Datum of 1988
- ASCII: American Standard Code for Information Interchange
- EDM: Electronic Distance Meter

2.0 MATERIALS AND EQUIPMENT

2.1 MATERIALS

2.1.1 Field Books and Data Sheets

The necessary field data shall be recorded by the surveyor in a field logbook using generally accepted surveying field note recording practices. The data shall be clear, neat, and easily reproducible.

Field data collected in electronic media shall be secured and protected from potential loss. Resurveys, due to the loss of data, shall be completed at no additional cost.

2.1.2 Iron Pins

Iron pins shall consist of a 0.45 m (18-inch) length of reinforcement steel or equivalent, with a minimum diameter of 16 mm (5/8-inch).

2.1.3 Wooden Hubs

Wooden hubs shall be 50 mm x 50 mm (2-inch x 2-inch), at least 0.2 m (8-inch) long, milled from solid lumber, and shall be pointed on one end.

2.1.4 Wooden Stakes

Wooden stakes shall be 25 mm x 50 mm (1-inch x 2-inch), at least 0.9 m (3-feet) long, milled from solid lumber, and shall be pointed on one end. Wooden stakes shall be clearly marked with bright color (orange, red, or blue) weatherproof flagging and paint.

2.1.5 Concrete Monuments

Concrete monuments shall be as shown on Attachment A or equivalent submitted for review and approval. Concrete shall have a minimum compressive strength of 3000 psi at 28 days.

2.1.6 Miscellaneous

Miscellaneous materials (e.g., P-K nails, flagging, tacks, etc.) shall be of the type and quality normally used for land survey work.

2.2 EQUIPMENT

Sufficient quantities of equipment, materials, parts, tools, and supplies shall be maintained on site to meet the requirements of the work. Surveying equipment shall be subject to inspection, and if deemed unsatisfactory, the equipment shall be removed from the site and replaced with satisfactory equipment. Surveying instruments, (level, transit, EDM, etc.) shall have been inspected and calibrated by an authorized manufacturer's representative prior to the survey; a certificate of compliance shall be submitted prior to start of any work. Equipment shall be recalibrated as recommended by the manufacturer, or when the equipment is suspected of error.

3.0 EXECUTION OF THE WORK (OR "WORKMANSHIP")

When any survey work is conducted during the construction period, every effort shall be made to minimize interference with construction work by others. Any damage to other facilities shall be repaired or replaced at no additional cost. All work shall be completed in a safe and professional manner.

3.1 GENERAL

3.1.1 Field Operations

Survey crew personnel shall be competent and experienced in performing land survey work. All work shall be performed under the direct supervision of a Land Surveyor registered in the state of Washington. Drawings and calculations shall be signed, sealed, and certified and stamped by a Land Surveyor registered in the state of Washington.

3.1.2 Quality Standards

Standards of accuracy for all survey work shall be in accordance with FGCC standards and the minimum standards as set forth in the WAC-332-130. The datum for the horizontal control network in Washington shall be NAD83 (1991). Elevations and benchmarks shall be based on NAVD88. The degree of accuracy required will be provided with each work release(s). The class of control surveys shall be shown on all documents prepared.

3.1.3 Drawings

All survey drawings shall be created on a Computer Aided Design Drafting (CADD) system... The drawings shall be created by experienced CADD operators at off-site facilities. The CADD drawings shall be submitted on a CD disk in the following formats:

- AutoCAD Release 2004 or higher. Files in DWG format.
- An ASCII file of the survey data as collected by an electronic data collection system and a printout of the data (with appropriate explanatory notations) shall also be submitted.

All CADD drawings generated shall make use of any industry standard software prototype layer index CADD Drawings shall be in survey companies own drawing title block/format. CADD layer convention shall be consistent and identified. All CADD files shall be created at 1 to 1 scale (i.e. 0.1 m is equal to 0.1 m in the drawing file). Drawings shall be submitted in an appropriate scale as required and specified in the work release(s).

3.2 GRID SURVEYS

3.2.1 Field Operations

Grid surveys shall be performed within the limits specified in the work release(s). Unless noted otherwise, the intersection of the grid lines shall be marked with a wooden hub and tack driven flush with the ground to a minimum depth of 0.2 m (8-inch). Where wooden hubs can not be driven, P.K. nails (driven flush to the ground) or chiseled crosses shall be used to establish grid intersection points. The coordinates and elevations of the hubs at the grid points shall be established, recorded, and marked on wooden stakes driven within 0.3 m (12-inch) of said hubs. Spray paint marking on buildings, structures, or pavements shall not be used.

Where the grid intersection location is obstructed by physical barriers, wooden hubs shall be set on the grid line to mark the obstruction and the offset marked on the stake. The coordinates and ground surface elevation at these points shall be established, recorded, and marked as described above.

Coordinates for grid surveys shall be based on the NAD83 (1991) coordinate system. Grid marks shall be as specified in the work release(s). The grid shall be referenced to permanent features within or immediately adjacent to, the survey area so that the grid may be readily reestablished in the event that it is removed or disturbed.

Pertinent data and information obtained and/or established during the grid surveys shall be shown on the drawings for submittal in accordance with this specification.

3.2.2 Office Work

Drawings for grid surveys shall have a scale in accordance with the work release(s). Drawings and documentation for grid surveys shall show but not limited to:

- Plan of area grid
- Coordinates and elevations of grid intersection points and of other points along the grid lines shown in tabular form
- Grid lines, bench marks, and all other miscellaneous data pertinent to the grid survey
- Fence lines and major structures (buildings, storage tanks, etc.)
- Ties to the NAD83 (1991) and NAVD88 coordinate system sufficient to enable the survey to be reestablished at a future date.

3.3 TOPOGRAPHIC SURVEYS

3.3.1 Field Operations

Topographic surveys shall be performed within the limits defined in the work release(s). The vertical datum shall be based on NAVD88. Sufficient surface elevations shall be measured to define the contour interval required on the drawings and to define all breaks in the terrain. Pertinent data and information such as, but not limited to: paved surfaces, vegetation, fences, power poles, walkways, underground utility (which can be seen above ground like manholes. Valve boxes, fire hydrants, electrical junction boxes, etc.), culverts (type and size), structures, any permanent structure, and all other features shall be shown on the drawings for submittal, in accordance with this specification.

3.3.2 Office Work

Drawings for topographic surveys shall have a horizontal scale and a contour interval of 0.5 meter of vertical relief, or as otherwise indicated in the specific work release(s). Drawings for topographic surveys shall show but not be limited to:

- Fence lines, major structures (buildings, storage tanks, etc.)
- Contours of the terrain and elevations of breaks in the terrain
- Bench marks and all other miscellaneous data pertinent to the topographic survey
- Ties to the NAD83 (1991) and NAVD88 coordinate system sufficient to enable the survey to be reestablished at a future date
- Paved surfaces, vegetation, power poles, walkways, underground utility, and all other features and obstructions.

3.4 GEODETIC SURVEYS

3.4.1 Field Operations

Geodetic surveys shall be performed within the limits specified in the work release(s). Horizontal and vertical control work shall be established from known coordinates and elevations in accordance with this specification.

3.4.2 Office Work

Horizontal and vertical control shall have ties to NAD83 (1991) and NAVD88 coordinate systems, sufficient to enable the survey to be reestablished at a future date. The class of control surveys shall be shown on all documents prepared. Data submittals shall be in accordance with the work release(s).

3.5 CONSTRUCTION SURVEYS

3.5.1 Field Operations

All construction surveys and related calculations shall be performed in accordance with the requirements stated in the work release(s). Pertinent data and information obtained and/or established during the construction surveys shall be submitted as directed. Construction surveys shall include, but not be limited to:

- Grade stakes for cut and fill marks
- Basic elevations
- Sewer line alignments and manholes
- Water line installations
- As-built information for monitoring well installations
- Power line installations
- Fence installations.

3.5.2 Office Work

Drawings and calculations for construction surveys, when required by the work release(s), shall conform to this specification.

3.6 BOUNDARY SURVEYS

3.6.1 Field Operations

Surveys and deed research necessary to define the property boundaries for the properties shown on the drawings shall be performed as directed.

Coordinates for all boundary surveys shall be based on the local state plane coordinate system.

Concrete or metal monuments or iron pins, as indicated on the drawings, shall be set at each property corner not having a permanent marker.

Pertinent information obtained and/or established during the boundary surveys shall be shown on the drawings for submittal on magnetic media for review in accordance with this specification.

3.6.2 Office Work

Drawings for boundary surveys shall have a scale and shall show but not limited to the following:

- Major structures (buildings, storage tanks, etc.)
- Property corners and lines
- Tie to closest street intersection

- State plane coordinates for two property corners
- Property line dimensions, political boundaries, bearings and other miscellaneous data pertinent to the boundary survey.

3.7 PLANIMETRIC SURVEYS

3.7.1 Field Operations

Planimetric surveys within the limits shown on the drawings shall be performed as directed.

All planimetric features shall be located, including but not limited to paved surfaces, vegetation, fences, power poles, walkways, underground utilities, structures and all other obstructions.

Pertinent data and information obtained and/or established during the planimetric surveys shall be shown on the drawings for submittal on magnetic media for review in accordance with this specification.

3.7.2 Office Work

Drawings for planimetric surveys shall have a scale and shall show but not limited to the following:

- Property lines and major structures (buildings, storage tanks, etc.)
- All planimetric features, including but not limited to, paved surfaces, vegetation, fences, power poles, walkways, underground utilities, structures and all other obstructions
- Bench marks and all miscellaneous data pertinent to the planimetric survey
- Ties to the state plane coordinate system sufficient to enable the survey to be reestablished at a future date.

4.0 SUBMITTALS

4.1 GENERAL

All required technical submittals stated herein or elsewhere in this specification shall be submitted for review and approval in accordance with "Exhibit I," SSRS. Documentation submitted will be reviewed for its accuracy and completeness. Any documentation such as schedules, methods, equipment, plans, drawings, or other submittals that do not meet the specified requirements shall be subject to rejection. Any such rejected or disapproved submittals shall be corrected and resubmitted for approval.

4.2 DRAWING SUBMITTAL

Reproducible copies of the drawings shall be submitted for review within ten working days after completion of any survey. Any comments shall be incorporated and final certified drawings shall be submitted within five working days of the receipt of the comments. Drawing format shall meet requirements outlined in this specification.

Along with reproducible copies of drawings, electronic drawing files in the following format shall be submitted:

- Compact disk (CD)

Copies of layering convention, blocks, symbol, or any other libraries used in the generation of CADD drawings pertaining to the work release(s), in a format as outlined in this specification, shall be submitted.

4.3 EQUIPMENT CALIBRATION SHEETS

All equipment to be used on the project shall be calibrated by the manufacture and proof of such current calibration shall be submitted prior to NTP for each work release.

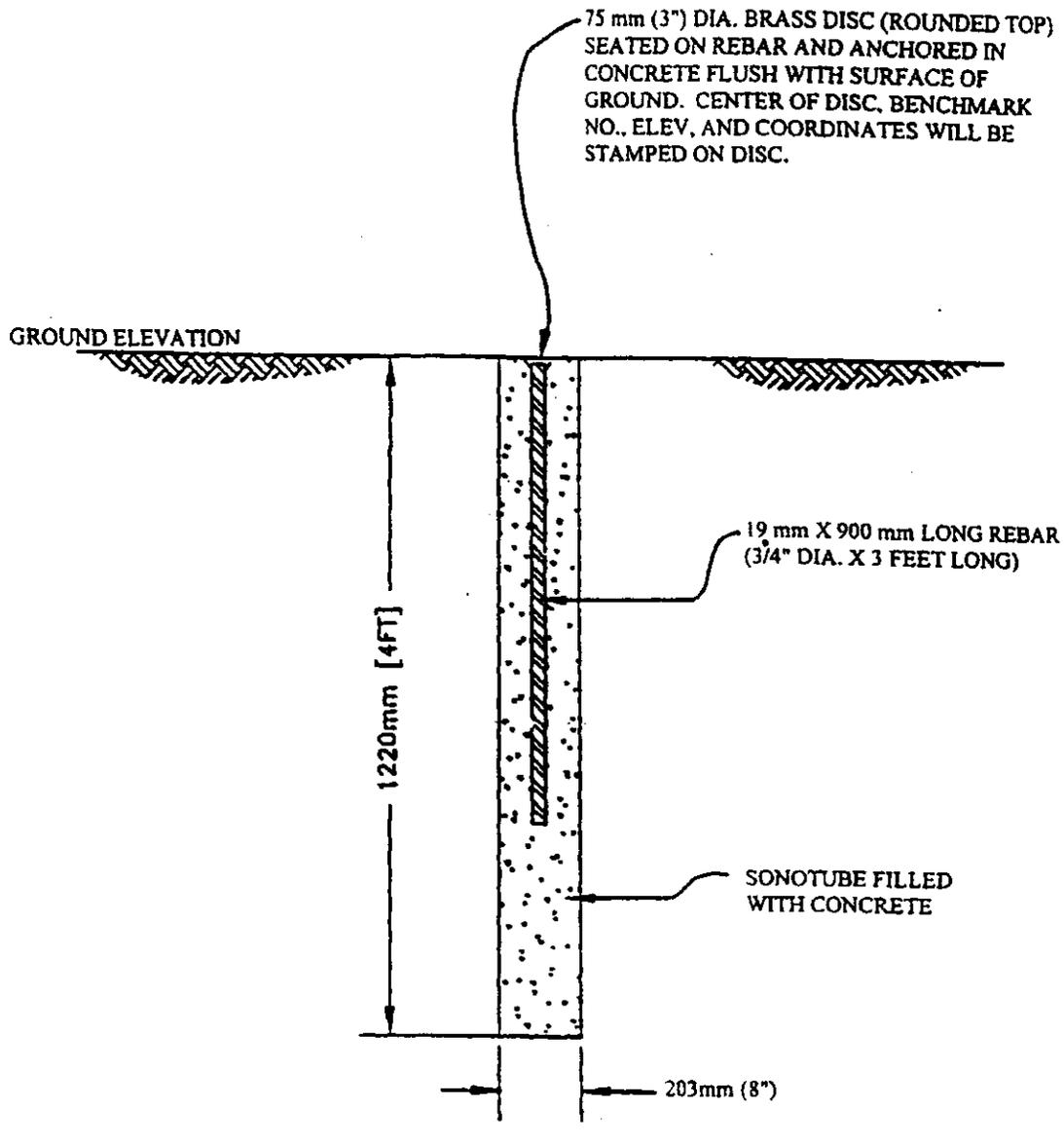
4.4 WASHINGTON STATE SURVEYOR'S LICENSE

A current Washington State Land Surveyors license is required for carrying out survey work on this project. A proof of such license shall be submitted prior to NTP.

4.5 SURVEY LOGBOOKS

Survey logbooks and when applicable electronic data shall be completed to provide traceability to the original data.

ATTACHMENT A CONCRETE SURVEYING MONUMENT DETAIL



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CELL CONSTRUCTION – ADMIX LAYER

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CELL CONSTRUCTION – ADMIX LAYER

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for the Admix Layer of the liner for the Environmental Restoration Disposal Facility (ERDF).

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ASTM	American Society for Testing and Materials
API	American Petroleum Institute
CQA	Construction Quality Assurance
CQAP	Construction Quality Assurance Plan
EPA	Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HDPE	High Density Polyethylene
CQC	Construction Quality Control
QAP	Quality Assurance Plan
SSRS	Subcontractor Submittal Requirements Summary
USCS	Unified Soil Classification System

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Cell Construction. Referenced test methods, specifications, and recommended practices shall be used to verify material properties and to identify acceptable practices applicable to Cell Construction. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kNm/m ³))
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5093	Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed Inner Ring
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
API Spec13A	API Specification for Drilling-Fluid Materials.
EPA/600/R-93/182	EPA, Technical Guidance Document, Quality Assurance and Quality Control for Waste Containment Facilities*
WAC 173 216	State Waste Discharge Permit Program
WAC 173 400	General Regulations for Air Pollution Sources

- * Note that an update to EPA/600/R-93/182 has been published: Daniel, D.E. and Koerner, R. M. (2007). *Waste Containment Facilities: Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems*, second ed., ASCE, New York, NY, 351 pp.

1.4 TECHNICAL SUBMITTALS

Submittals shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor Submittal Requirements Summary (SSRS). Submittals that do not meet requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.4.1 Manufacturer's Data

Manufacturer's descriptive data, specification sheets, literature, and other data necessary to fully demonstrate compliance with the requirements of these specifications.

1.4.2 Admix Preparation Plan

The SUBCONTRACTOR shall submit a detailed plan for preparation of the admix material, including a description of the equipment, calibrations, tests, and procedures to be used; personnel qualifications; hold points; site plan showing pugmill plant and stockpile locations; bentonite storage equipment and procedures; productivity rates; stockpile maintenance procedures; test fill plan; and methods for monitoring bentonite addition and moisture conditioning. The Admix Preparation Plan shall be approved by the CONTRACTOR prior to the start of admix production for the test pad and cell liners.

1.4.3 Admix Liner Placement Plan

The SUBCONTRACTOR shall submit an Admix Liner Placement Plan to specify placement equipment and methods, lift thickness control, admix layer maintenance, finished surface protection, hold points, haul routes, productivity rates, survey and/or GPS records, repair procedures, required testing described in the Construction Quality Control (CQC) Plan and CQAP for this project. This Admix Liner Placement Plan shall be approved by the CONTRACTOR prior to the start of admix placement for the Test Fill or Trench Liner.

1.4.4 Quality Control Certification

Certifications for material composition and properties, Construction Quality Control CQC tests, admix surface, equipment calibration, and other work activities as described in these specifications.

1.5 DESCRIPTION

This section includes the work for furnishing, preparing, handling, installing, and finishing/trimming the Admix layer.

Admix consists of soil that is mixed with bentonite, moisture conditioned, placed, compacted, and trimmed to form the soil liner for the ERDF.

2.0 MATERIALS AND EQUIPMENT

2.1 BENTONITE FOR THE ADMIX LAYER

The bentonite used in the admix shall consist of a commercially prepared material meeting the requirements of API Specification 13A, Section 4, with a minimum yield of 91 barrels. The bentonite shall have a free swell of 15 ml per 2 gm or greater (ASTM D5890) and a maximum Fluid Loss of 15ml (ASTM D5891). Acceptable products shall have been used in similar applications.

The SUBCONTRACTOR shall submit manufacturer's information and test data to demonstrate that the proposed bentonite conforms to the requirements of these specifications. The Manufacturer shall certify that the bentonite furnished complies with these specifications. A certificate shall be submitted to the CONTRACTOR for each 450 metric tons (500 tons) of bentonite delivered.

The SUBCONTRACTOR shall provide suitable containers on site to store bentonite in a dry condition prior to use. SUBCONTRACTOR shall perform inspections of storage containers to ensure proper condition is maintained during storage.

2.2 BASE SOIL FOR THE ADMIX LAYER

The base soil for the admix layer shall consist of soil derived from the ERDF excavation having a USCS Classification SM, SW, SC, MH, ML in accordance with ASTM D2487, or other soil approved by the CONTRACTOR. The base soil shall be obtained from soils excavated during construction and placed in a dedicated stockpile constructed for this purpose. Material from other stockpiles shall not be used without approval of the CONTRACTOR. The base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious material. No rocks greater than 50 mm (2 in.) in dimension will be allowed in the admix liner. Base soil shall be classified and screened if necessary to meet this requirement.

To ensure the quantity of base soil required to construct the admix layer is available; the SUBCONTRACTOR shall excavate and stockpile base soil prior to stockpiling excess soil in the stockpile area shown on the Exhibit "F" Drawings.

2.3 ADMIX LAYER MATERIALS

2.3.1 Properties

The properties of the admix when mixed uniformly and placed according to the specifications, shall have a maximum saturated hydraulic conductivity of 1×10^{-7} cm/sec (3.94×10^{-8} in/sec) and have a USCS classification of ML, CL, CH, or SC.

The finished admix shall have the following properties:

Fraction passing the U.S. No. 200 sieve:	>30%
Liquid Limit:	>30
Plasticity Index:	>15

For evaluating compliance with these requirements, test results shall be considered acceptable when the average value of the data satisfies the associated criterion.

2.3.2 Composition

The admix shall consist of the base soil mixed with a nominal bentonite content of 12 percent by dry weight. The acceptable range for bentonite content shall be a minimum of 11 percent and maximum of 14 percent of base soil by dry weight. The admix shall be prepared at a moisture content that ranges from approximately 15 to 20 percent. The moisture content range may change as a result of preconstruction testing performed by the SUBCONTRACTOR and CONTRACTOR as described in the CQC and CQAP Plans, and may be modified by the CONTRACTOR at any time during the admix preparation process to reflect changes in the base soil or other components. The moisture content and bentonite dispersion in the admix shall be uniform and homogenous. The finished admix shall be a uniform homogenous material. SUBCONTRACTOR shall maintain records available to the CONTRACTOR verifying these requirements are maintained.

2.3.3 Testing

The admix shall be prepared and tested by the SUBCONTRACTOR in accordance with the CQC Plan. The SUBCONTRACTOR shall make the admix stockpiles available to the CQA SUBCONTRACTOR and CONTRACTOR for sampling, testing, or visual observation.

3.0 EXECUTION

3.1 GENERAL

3.1.1 Unacceptable Materials and Work

Materials and work that fail to meet the requirements of these specifications shall be removed and disposed of at the SUBCONTRACTOR's expense.

3.2 ADMIX PREPARATION

The SUBCONTRACTOR shall provide necessary equipment and labor to operate the pugmill, load material into pugmill, offload admix, and stockpile admix.

3.2.1 Equipment

Admix shall be prepared using a pugmill with the following characteristics and ancillary equipment:

- a. Continuous mixing pugmill.
- b. Belt scales on base soil, bentonite, and finished product belts.
- c. Feed rate meters and totalizers for bentonite, base soil, and water.
- d. Production rate meters and totalizers for finished product.
- e. Equipment shall be capable of production rates to meet schedule requirements.
- f. Equipment shall be readily repairable (e.g. not experience downtime periods greater than 48 hours, repair parts are available).

Measuring equipment shall be calibrated and calibration certificates submitted to the CONTRACTOR prior to starting admix production.

3.2.2 Personnel Qualifications

The pugmill operator shall have completed three similar projects with a minimum of 45,360 metric tons (50,000 tons) of acceptable amended soil on each project. Submit evidence to demonstrate the qualifications of the pugmill operator.

3.2.3 Base Soil Excavation and Stockpiling

During excavation and stockpiling, base soil liner materials shall be inspected to document compliance with the requirements of the specifications. Material inspection shall continue throughout the liner construction period. Visual observation and classification of the excavated base soils used in admix production shall be performed. Unsuitable material shall be rejected. For borrow areas containing non-uniform materials, unacceptable soil material shall be segregated as it is excavated. SUBCONTRACTOR shall observe segregation operations carefully and continuously to document that only suitable base soil material is retained for liner construction. Changes in color or texture may be indicative of a change in soil type or soil moisture content.

3.2.4 Preparation Requirements

Admix shall be prepared at least 24 hours prior to placement in the landfill. The SUBCONTRACTOR shall be responsible for maintaining and sealing the stockpiled material to protect the moisture content of the admix within the specified limits. Admix that does not meet specifications shall not be reused as feed stock unless approved by the CONTRACTOR.

3.2.5 Admix Preparation Plan

The SUBCONTRACTOR shall submit a detailed plan for preparation of the admix material, including a description of the equipment and procedures to be used, proposed production rate,

records to be maintained, start-up plan that includes a demonstration that the proposed production rates can be consistently achieved, personnel qualifications, and methods for monitoring bentonite and base soil addition and moisture conditioning. This plan shall be approved by the CONTRACTOR prior to the start of admix production.

3.3 TEST FILL

A test fill shall be constructed by the SUBCONTRACTOR to demonstrate the adequacy of the materials, design, equipment, and construction procedures proposed for the admix liner. The primary purpose of the test fill is to document that the specified soil density, moisture content, and permeability values can be achieved consistently in the full-scale facility with the full-scale compaction equipment and procedures. The location of the test fill will be designated by the CONTRACTOR. Testing shall be conducted by the SUBCONTRACTOR. CONTRACTOR or others may also conduct testing.

So that the test fill will accurately represent the performance of the full-scale facility, the following requirements shall be followed:

- Construction of the test fill shall use the same soil material, design specifications, equipment, and procedures as proposed for the full-scale facility.
- The test fill shall be constructed at least four times wider than the widest piece of construction equipment to be used for the full-scale facility. This is done to ensure a sufficient area to conduct testing after a buffer area has been left along the edges of the test fill.
- The test fill shall be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing.
- The test fill shall be constructed with at least six lifts to evaluate the methodology used to tie lifts together.
- The test fill shall be constructed to allow determination of the relationship among density, moisture content, and permeability. Field variables can affect this relationship and shall be carefully measured and controlled both in the test fill and during construction of the full-scale liner. As a minimum, the following shall be observed, sampled, tested, and documented by the SUBCONTRACTOR:
 - the compaction equipment type, configuration, length of peg foot, and weight
 - the number of passes of the compaction equipment
 - the method used to breakdown clods before compaction and the maximum allowable clod size

- the method used to control and adjust moisture content, including time to equilibrate and the quantity of water to be used in any adjustment
 - the speed of the compaction equipment traveling over the liner
 - the uncompacted and compacted lift thicknesses
 - types of rutting (depths, widths, etc.).
- SUBCONTRACTOR shall assist the CQA Subcontractor in collecting Shelby tubes for laboratory permeability tests.
 - Following collection of permeability samples, the methodology for repairing holes in the soil liner shall be evaluated. The evaluation of a repaired area shall include all tests previously required for undisturbed portions of the test fill. The methods and materials that will be used in the repair process shall be documented by the SUBCONTRACTOR. Performance of repaired soil liner sections shall be equal to or exceed the performance of undisturbed liner sections. The resulting procedures shall be followed during repair of testing or sampling holes during full-scale liner construction.
 - The test fill construction shall include the removal and replacement of a portion of the soil liner to evaluate the method proposed for repair of defective portions of the full-scale liner.
 - The CQA Subcontractor will conduct a Sealed Double Ring Infiltrometer (SDRI) Test (ASTM D5093) on the test fill to evaluate large-scale permeability. The CQA Subcontractor will furnish the SDRI and equipment (insulated cover, water heaters, etc.) to protect the SDRI from the environment. The SUBCONTRACTOR shall
 - Furnish the equipment, operators, and laborers required to install and remove the SDRI associated equipment.
 - Furnish, install, and maintain thermal blankets to protect the test pad until installation of the SDRI and associated weather protection equipment are installed.
 - Furnish, install, and maintain the electrical power supply for the SDRI equipment and water heaters.
 - SUBCONTRACTOR shall assist the CQA Subcontractor to evaluate layer bonding by excavating test pits so CQA Subcontractor can make visual observations. A minimum of two test pits shall be excavated in each test fill after test fill construction has been completed. The test pits shall be excavated entirely through the test fill using a backhoe, posthole digger, or other approved method. Test pit locations shall be determined by the CONTRACTOR and CQA Subcontractor.

No soil liner shall be placed within the cell limits until the test fill has been constructed and the results from tests, including the SDRI test, indicate that the admix will satisfy the permeability requirements specified in this section. The SDRI test is conducted until a steady-state infiltration

rate is achieved. SDRI tests for previous ERDF Cells have taken 2 to 4 days to install and then up to 90 calendar days of monitoring. Additional test fills shall be constructed for each borrow source and whenever significant changes occur in the liner material, equipment, or procedures used to construct the full-scale soil liner. Changes to the admix preparation procedures after acceptance of test pad does not automatically require a new test fill, but a new test fill may be required if the final admix product varies significantly in properties and composition. Installing replacement components in the pugmill or replacing a defective pugmill with a like-kind replacement would likely not require a new test fill. Conversely, if there was a change in the properties of the bentonite, base soil, or finished admix product, a new test fill shall be required. If the additional test fill is required because of changes in the equipment or procedures initiated by the SUBCONTRACTOR, the SUBCONTRACTOR shall reimburse CONTRACTOR for the CQA SUBCONTRACTOR and surveying costs associated with the new test fill.

After testing has been completed and approved, the admix can be used by the SUBCONTRACTOR for liner construction provided that the material satisfies the requirements of these specifications.

3.4 SUBGRADE PREPARATION

3.4.1 General Requirements

The surface of the subgrade shall be graded to lines, grades, and tolerances shown on the Drawings. The subgrade surface shall be rolled flat and shall be smooth and free of ruts. Admix shall not be placed on frozen subgrade soils or ponded water. The subgrade shall be tested by the SUBCONTRACTOR as described in the CQC Plan.

3.4.2 Compaction - Trench Floor

On the trench floor, the top 200 mm (8 in.) of the excavated subgrade surface shall be scarified with a disc and re-compacted to 90 percent of the maximum dry density as determined by the Modified Proctor density test (ASTM D1557).

3.4.3 Compaction - Trench Side Slopes

On the side slopes of the trench, the following procedure shall be used to prepare the subgrade for placement of admix:

1. Windrows or piles of loose material produced by trimming operations shall be removed.
2. The trimmed surface shall be watered so that moisture penetrates a minimum of 100mm (4 in.) into the subgrade. Care shall be exercised during watering so that the subgrade is not disturbed and rills, gullies, and other erosional features are prevented.
3. The trimmed and watered surface shall be track walked by dozer to produce a firm and stable subgrade.

4. Visual monitoring of the subgrade preparation on sideslopes shall be performed by the CONTRACTOR.

3.4.4 Subgrade Fill

In locations on the sideslope where less than 200 mm (8 in.) of fill is required to reach the subgrade design grade, suitable moisture-conditioned fill material shall be placed and compacted as described in Section 3.4.3. For purpose of this section, "suitable fill material" is defined as materials classified in ASTM D 2487 as GW, GP, GM, GW-GM, SW, SP, SM, SP-SM and SW-SM and free from roots and other organic matter, trash, debris, and frozen materials.

In locations on the trench floor or locations on the sideslope where more than 200 mm (8 in.) of fill is required to reach the design grade, subgrade shall be placed, compacted, and tested in accordance with the requirements for Fills and Embankments specified in the Technical Specification for Site Work, 0600X-SP-C0072.

3.5 ADMIX PLACEMENT AND COMPACTION

Manufacture of admix material for the liner system shall not begin until testing on the test fill is complete, including the SDRI test, and the CQA Subcontractor's tests on the test fill indicate that the SUBCONTRACTOR's materials, equipment, and construction procedures will provide an admix liner meeting the specified requirements.

3.5.1 Lift Thickness

The admix material shall be placed in maximum 250 mm (10 in.) thick loose lifts and compacted such that the compacted lift thickness is 150 mm (6 in.) or less. However, the first lift of admix placed over subgrade soils may be placed in a 300 to 400 mm (12 to 16 in.) thick loose lift thickness and compacted to a maximum thickness of 200 mm (8 in.). SUBCONTRACTOR shall use laser or GPS guidance to maintain proper lift thickness on all spreading equipment. Clods greater than 75 mm (3 in.) shall be broken down prior to compaction.

Placement methods shall prevent excessive mixing of admix with subgrade soil. If in the judgment of the CONTRACTOR, excessive mixing occurs that could compromise the integrity of the liner, the unacceptable admix shall be removed, the subgrade recompacted and prepared in accordance with these specifications, and new admix placed. The new admix shall be subject to the same restrictions on excessive mixing with the subgrade.

3.5.2 Compaction

Compaction equipment used on the full-scale liner shall be the same type, configuration, and weight as used in the test fill. The equipment speed and number of passes for compaction shall be the same as used in the test fill. Coverage by compaction equipment shall be uniform; special

attention shall be paid to compacted fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes.

The admix shall be compacted to a dry density that corresponds to at least 85 percent saturation assuming a specific gravity of 2.7. The moisture-density range of the compacted admix shall lie within a trapezoidal-shaped field with the following corners:

Moisture Content (%)	Dry Density (pcf)	Dry Density (kg/m ³)
15	115	1,842
15	121	1,938
20	104	1,666
20	110	1,762

The corner values of this acceptable field shall be modified using the method given in the EPA Technical Guidance Document (EPA/600/R-93/182) based on actual field values developed by the SUBCONTRACTOR at any time during admix preparation or placement to reflect changes in the base soil or other components.

Sufficient liner strength to maintain stable sidewalls and to supply a stable base for supporting overlying materials shall be maintained while achieving the minimum specified density. This shall be monitored by the SUBCONTRACTOR with moisture-density testing in accordance with the procedures listed in the CQA Plan.

Penetrations or holes resulting from the collection of undisturbed soil samples or the use of density or moisture probes shall be repaired using the same materials and methods used for repairs on the test fill. SUBCONTRACTOR shall repair holes resulting from sampling or testing activities.

3.5.3 Permeability

The in-place compacted admix liner shall achieve a saturated permeability of 1×10^{-7} cm/sec (3.94×10^{-8} in/sec) or less.

3.5.4 Uniformity

The compacted admix distribution and gradation throughout the liner shall be free from lenses, pockets, streaks, layers, or material differing substantially in texture, moisture content, dry density, or gradation from surrounding material. The admix shall be free of organic debris, frozen material, rubbish, construction debris, 50mm (2 in.) rocks and other deleterious material. Any admix containing unacceptable material shall be removed and discarded.

3.5.5 Moisture Conditioning

The moisture content of the admix shall be uniform throughout each lift prior to and during compaction of the material. If the moisture content of a lift of compacted admix falls below the acceptable limit during placement operations, the SUBCONTRACTOR shall moisture condition the dry soil and recompact the lift prior to placement of additional lifts. If the moisture content of a layer of compacted admix exceeds the acceptable limit due to precipitation or over watering, the SUBCONTRACTOR, before placement of additional lifts, shall either allow the wet soil to dry back within acceptable limits or remove the wet soil. If the admix cannot be conditioned to meet the placement specifications, the material shall be removed and replaced with new admix material.

3.5.6 Placement Equipment

The SUBCONTRACTOR shall place layers of admix to form a continuous monolithic liner. Admix shall be placed and compacted with a self-propelled pegfoot or padfoot roller compactor having a minimum operating weight of 18,160 kg (40,000 pounds) or CONTRACTOR approved equal. Hauling and spreading equipment will not be considered as compaction equipment. The compactor feet shall be sufficiently long to knead (bond) new lifts into previously placed lifts. The feet shall be kept free of large amounts of dried admix that might restrict foot penetration or become incorporated into the admix lift. If necessary to promote bonding of subsequent lifts, the top of each lift shall be scarified with suitable equipment such as a disc, and wetted prior to placing the next lift. The final lift of admix may be compacted with a smooth drum roller after it has been compacted with the pegfoot compactor provided that other requirements are met.

3.5.7 Placement Method

Admix shall be placed on the side slopes in either horizontal lifts (along the contour) or in lifts parallel to the slope (up and down the slope). If admix is placed parallel to the slope, compaction equipment shall not spin their wheels or in any other way disturb the previously placed lifts. If this occurs, the SUBCONTRACTOR shall place the admix in horizontal lifts.

Side slopes shall be overbuilt to protect the admix from excessive drying. Admix placed on the floor shall be placed in a method that will prevent ponding of water and excessive drying between lifts.

3.5.8 Restrictions

Production, mixing, and stockpiling of admix shall be restricted to the construction limits shown on the Drawings and will not be allowed within the landfill footprint.

3.5.9 Tie-in Areas

Where new admix is tied-in to existing admix liner, any areas of the existing admix which are soft, cracked, or otherwise unsuitable shall be removed until acceptable material is exposed to

the satisfaction of the CONTRACTOR. The edge of the existing admix shall be trimmed to the configuration indicated on the drawings. Where new admix will be placed, the surface of the existing admix shall be scarified and moisture conditioned as specified in this section. New admix shall be placed in accordance with the requirements of this specification and shall be thoroughly mixed into the existing admix to form a monolithic mass free of seams or other discontinuities.

3.6 ADMIX SURFACE FINISHING, PROTECTION, AND MAINTENANCE

The surface of the admix shall be trimmed just prior to geomembrane deployment to the design grades and tolerances as shown on the Drawings. The surface shall be graded such that the design grades are achieved throughout the trench, not just at survey grid points. The surface of the admix shall be rolled with a smooth-drum roller to remove ridges and surface irregularities. Ruts on the surface of the admix liner that are deeper than 25 mm (1 in.) and desiccation cracks or other cracks that are deeper than 25 mm (1 in.) or wider than 5 mm (0.25 in.) shall be repaired by the SUBCONTRACTOR prior to placement of the geomembrane.

3.6.1 Maintenance

The SUBCONTRACTOR shall maintain the admix liner surface in a condition suitable for geomembrane installation until the surface is covered. This may be accomplished by periodic watering, exclusion of traffic, or other methods.

The SUBCONTRACTOR shall take measures to prevent the admix liner from freezing. Lifts of admix shall not be placed on frozen surfaces. In the event that the admix surface freezes before geomembrane is placed, the CONTRACTOR may direct additional evaluation of admix properties by the SUBCONTRACTOR. Geomembrane shall not be placed on a surface which is frozen or has been frozen and thawed until directed by the CONTRACTOR.

3.6.2 Repair of Admix Liner

The SUBCONTRACTOR shall repair the surface of any areas identified by the SUBCONTRACTOR, CONTRACTOR, or CQA SUBCONTRACTOR to be out of tolerance. Repair as follows:

- a. Remove admix that does not meet specifications.
- b. Scarify surface and spray with water.
- c. Place additional approved admix.
- d. Compact admix with self-propelled pegfoot or padfoot type compactor as described above.
- e. Trim and roll the surface as described above to design grades and tolerances.

Alternative methods for repair of the admix liner will be allowed if submitted by the SUBCONTRACTOR and approved by the CONTRACTOR. Minor rills, gulleys, ruts, or other local anomalies that are less than 50 mm (2 in.) deep and 100 mm (4 in.) wide, may be repaired by backfilling with admix liner and hand-tamping with a suitable device to firmly compact the backfill.

SUBCONTRACTOR personnel shall repair small holes resulting from CONTRACTOR sampling, SUBCONTRACTOR sampling and other CQC activities. The CQA SUBCONTRACTOR shall repair sampling holes caused by the CQA SUBCONTRACTOR. Holes less than or equal to 150 mm (6 in.) in diameter shall be repaired by backfilling with bentonite or admix liner in lifts no more than 50 mm (2in.) thick and hand-tamping with a steel rod or other suitable device to firmly compact each lift.

3.6.3 Admix Liner Surface Preparation

The SUBCONTRACTOR shall be responsible for preparing the surface of the admix liner according to the Specifications. Surfaces to be lined shall be smooth and free of rocks/stones, larger than 25mm (2 in.) sticks, roots, sharp objects, or debris. The surface shall provide a stable foundation for the membrane with no sudden, sharp, or abrupt changes at break in grade. No standing water or excessive moisture shall be allowed to accumulate on the subgrade. In addition to the surface deformities specifications described previously, no voids or depressions larger than 50 mm (2 in.) in any dimension shall be allowed. Such voids and depressions shall be filled with admix material to complete a level surface.

The CQA SUBCONTRACTOR and SUBCONTRACTOR/Geosynthetic Lining Subcontractor shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given to the CONTRACTOR prior to commencement of geomembrane installation in the area under consideration.

Slope of the Liner Surface shall be in accordance with drawings.

After the soil liner surface has been accepted by the installer, it shall be the SUBCONTRACTOR's responsibility to indicate to the CONTRACTOR any change in the soil liner surface condition that may require repair work. If the CQA Subcontractor concurs, the SUBCONTRACTOR shall ensure that the soil liner surface is repaired.

Special care shall be taken to avoid desiccation cracking of the admix liner. The surface of the admix liner shall be maintained in the required condition throughout the course of geomembrane installation.

3.7 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

Records submitted to CONTRACTOR shall include, but not be limited to the following:

- (1) Measurement of weight and volume of materials used in admix, from scales, meters, and totalizers.
- (2) Calibration of scales, meters, totalizers, and other equipment used to prepare admix. Calibration shall be at manufacturers' recommended intervals or whenever rough handling, damage, or other factors indicate that accuracy may have been compromised. Methods used for calibration shall conform to manufacturers' recommendations. Secondary standards shall be traceable to national standards.
- (3) Control of individual lift thickness during placement and overall admix layer thickness. Subgrade and final admix surface elevations shall be determined by surveying on a minimum 15.24 m (50 ft) grid and at grade breaks over the floor and side slopes of the disposal trench except that detailed surveying shall be required in the sump area and other locations to establish grade breaks and slope continuity as directed by the CONTRACTOR. Vertical survey accuracy shall be plus or minus 15 mm (0.05 ft) or better. Results shall be provided to the CONTRACTOR. No liner system materials shall be installed on the finished surface until satisfactory thickness of the admix layer has been verified.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory shall be furnished to the CONTRACTOR within one working day following the inspection or test.

SPECIFICATION FOR

DOCUMENT CONTROL mjp 10/11/07

CELL CONSTRUCTION - GEOSYNTHETICS

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)

CELLS 7, 8, 9, & 10 CONSTRUCTION

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SUPPLIER/SUBCONTRACTOR DOCUMENT STATUS STAMP		
1. <input checked="" type="checkbox"/> Work may proceed. 2. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission. 3. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission subject to resolution of indicated comments. 4. <input type="checkbox"/> Revise and resubmit. Work may not proceed. 5. <input type="checkbox"/> Permission to proceed not required.		
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<u>Bill Borlaug</u> Project Engineer/STR	<u>10/9/07</u> Date	
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EXPIRES: 5/28/08

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Washington Closure Hanford, LLC		RIVER CORRIDOR CLOSURE CONTRACT	Job No. 14655	Specification No. <u>0600X-SP-C0068</u>	RECEIVED	
			Page <u>1</u> of <u>46</u>	OCT 09 2007		

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CELL CONSTRUCTION - GEOSYNTHETICS

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for the Geosynthetics liner systems for the Environmental Restoration Disposal Facility (ERDF).

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ASTM	American Society for Testing and Materials
API	American Petroleum Institute
CQA	Construction Quality Assurance
EPA	Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HDPE	High Density Polyethylene
CQC	Construction Quality Control
QAP	Quality Assurance Plan
SSRS	Subcontractor/Supplier Submittal Requirements Summary

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Cell Construction. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Cell Construction. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D1004	Standard Test Method for Initial Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D1204	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kNm/m ³))
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics
ASTM D1777	Standard Test Method for Thickness of Textile Materials
ASTM D3786	Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Tester Method
ASTM D3895	Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4355	Standard Test Method for Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4716	Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Standard Test Method for Measuring Nominal Thickness of Geosynthetics
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5641	Standard Test method for Geomembrane Seam Evaluation by Vacuum Chamber
ASTM D5820	Standard Test Method for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
ASTM D5885	Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Seaming Calorimetry
ASTM D5721	Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seam Produced Using Thermo-Fusion Method
ASTM D6497	Standard Test Method for Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
ASTM D7005	Determining the Bonds Strength (Ply Adhesion) of Geocomposites
EPA/600/R-93/182	EPA, Technical Guidance Document, Quality Assurance and Quality Control for Waste Containment Facilities*
GRIGM-11	UV Resistance (Accelerated Weathering of Geomembranes Using Fluorescent UVA Condensation Exposure Device)
GRIGM-12	Asperity Height (Asperity Measurement of Textured Geomembranes Using a Depth Gauge)

GRIGM-19	Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
WAC 173 216	State Waste Discharge Permit Program
WAC 173 400	General Regulations for Air Pollution Sources

- * Note that an update to EPA/600/R-93/182 has been published: Daniel, D.E. and Koerner, R. M. (2007). *Waste Containment Facilities: Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems*, second ed., ASCE, New York, NY, 351 pp.

1.4 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor/Supplier Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.4.1 Manufacturer's Data

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these specifications. Certification that manufacturer has manufactured HDPE for at least 5 years and has manufactured a minimum of 929,000 square meters (10 million square feet).

1.4.2 Installation Plan

The SUBCONTRACTOR shall submit an installation plan describing the proposed methods for deployment, panel layout, seaming, including methods for connecting the new geosynthetics to the previously installed geosynthetics, repair, and protection. The plan shall include a quality control program for the SUBCONTRACTOR's activities related to geomembrane installation.

1.4.3 Quality Control Certification

Certifications for material composition and properties, Construction Quality Control (CQC) tests, admix surface, seam quality, equipment calibration, and other work activities as described in these specifications.

1.5 DESCRIPTION

Furnishing and installing the Geomembrane, Geotextile, and Geocomposite materials.

1.5.1 Geomembrane

The work includes manufacture, fabrication (if needed), supply, and installation of geomembrane as shown on the Drawings. Geomembrane is also referred to as High Density Polyethylene (HDPE) liner or flexible membrane liner (FML).

1.5.2 Geotextiles

The work includes manufacture, fabrication (if needed), supply, and installation of geotextiles as shown on the Drawings. This section also applies to geotextiles used to fabricate geocomposite drainage layers.

1.5.3 Geocomposites

The work includes manufacture, fabrication (if needed), supply, and installation of geocomposite drainage layers. The geocomposite will consist of a layer of geotextile 100% thermally bonded to each side of a geonet.

1.5.4 Interface Friction Testing Requirements

The materials used for construction shall meet the interface strength requirements of the design. To document that this requirement has been met, the SUBCONTRACTOR shall conduct the following test program prior to ordering materials.

Two sets of Interface Friction Testing in accordance with ASTM D5321 shall be conducted on the following interfaces:

- a. 60 mil textured geomembrane and the soil/bentonite admix
- b. 60 mil textured geomembrane and geocomposite
- c. Geocomposite and operations layer material

Testing shall be conducted under saturated conditions at nominal normal loads of 9.6, 19.2 and 28.8 kPa (200, 400 and 600 psf) to determine the peak angle and residual angle measured at a displacement of 50 cm. (2 in.). If the geomembrane texturing is variable, additional of tests will be required for interfaces with the geomembrane.

The residual friction angle of the interface friction testing shall meet the following minimum values with a normal load of 1955 Kg/m² (400 psf) a displacement of 50 cm (2 in) and a cohesion of 0.

- | | | |
|----|---|-------|
| a. | 60 mil geomembrane/soil-bentonite admix | 29.5° |
| b. | 60 mil geomembrane/geocomposite | 24.0° |
| c. | geocomposite/operations layer material | 29.5° |

The average asperity height of the textured geomembrane utilized in the interface friction testing program will set the standard for all textured materials manufactured and delivered for installation. Materials not meeting this requirement will be rejected from use unless another friction angle test program is conducted with adjacent materials to document conformance with the design requirements.

SUBCONTRACTOR shall submit the results of the interface friction testing prior to shipment of the material. The CONTRACTOR will review this data for conformance with project strength requirements. At the direction of the CONTRACTOR, a registered professional engineer licensed in the State of Washington will prepare a stability analysis using the submitted data. The analysis will evaluate the proposed material's strength to determine if the required factors of safety of 1.0 and 1.3 under seismic and static are met. Allow engineer 30 calendar days after receipt of the testing results for this evaluation.

Other combinations of shear strength parameters which can be shown by standard analytical techniques to provide static and dynamic factors of safety against slope failure that are equivalent or greater than those specified may be acceptable if approved by the CONTRACTOR.

2.0 MATERIALS AND EQUIPMENT

2.1 GEOMEMBRANE

2.1.1 Types of Geomembrane

- a. Geomembrane for the primary and secondary liner systems shall be un-reinforced HDPE, 1.52 mm (60 mil) thick, textured both sides.
- b. Geomembrane for miscellaneous applications including the crest pad, rub sheets in sumps, and other applications as shown on the Drawings shall be un-reinforced HDPE, 2.54 mm (100 mil) thick, smooth.
- c. Geomembrane shall be produced with a white surface.

2.1.2 Geomembrane Manufacturer

The HDPE Geomembrane Manufacturer shall have a minimum of five years of experience as a commercial manufacturer of HDPE geomembranes for landfill applications. Manufacturer shall have manufactured HDPE for at least 5 years and manufactured a minimum of 10 million square feet.

2.2 GEOMEMBRANE PROPERTIES

2.2.1 Use of Recycled Polymer

The raw material shall be new polyethylene resin containing no more than 2% clean recycled polymer by weight. Two percent recycled polymer shall not include any finished sheet material that has actually seen some type of service performance. Regrind, reworked or trim materials in the form of chips or edge strips that have not actually seen some type of use may be added, if the material is from the same manufacturer and is the same formulation as the geomembrane being produced.

2.2.2 Resin Properties

The raw resin, (without carbon black) shall meet the following specifications:

- a. Specific Gravity (ASTM D1505/D792): > 0.930.

2.2.3 Finished Sheet Properties

The physical, mechanical, and environmental properties of the finished sheet shall meet or exceed the values specified in the tables for Required Geomembrane Properties at the end of this Technical Specification section. Where applicable, values in the table are Minimum Average Values.

2.3 GEOMEMBRANE MANUFACTURING QUALITY CONTROL

2.3.1 Quality Control Testing

Quality control testing shall be carried out by the Manufacturer to demonstrate that the geomembrane meets the specifications specified above and in Geomembrane Tables. The CQA Subcontractor may carry out additional testing for purposes of determining conformance. If the results of the Manufacturer's and the CQA Subcontractor's testing differ significantly (i.e. greater than 10%), the testing shall be repeated by the CQA Subcontractor, and the Manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

2.3.2 Required Information

Prior to the delivery of any geomembrane material, the Manufacturer shall submit the following information:

- a. The origin (Resin Supplier's name, resin production plant), identification (brand name, number) and production date of the resin.

- b. A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.
- c. Copies of the quality control certificates issued by the Resin Supplier.
- d. Reports on the tests conducted by the Manufacturer to confirm that the quality of the resin used to manufacture the geomembrane satisfies these Specifications.
- e. A statement that recycled polymer (if any) is clean and does not exceed 2% by weight.
- f. A properties sheet including, at a minimum, specified properties, measured using test methods indicated in these specifications, or equivalent.
- g. Test reports, including sampling procedures, conducted by the Manufacturer to confirm that the geomembrane meets the specifications. Tests shall be conducted on each production lot of geomembrane or every 4,645 m² (50,000 square ft), whichever results in the greater number of tests.
- h. A certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

2.3.3 Certification

Prior to shipment, the Geomembrane Manufacturer shall provide a quality control certificate for each roll of geomembrane. The quality control certificate shall be signed by a responsible party employed by the Geomembrane Manufacturer, such as the production manager. The quality control certificate shall include:

- a. Roll numbers and identification, resin lot, and batch numbers.
- b. Sampling procedures and results of quality control tests.
- c. Information package containing the information required by Section 2.3.2

2.3.4 Manufacturing Plant Visit

The Manufacturer shall allow the CONTRACTOR or his designated representative to visit the manufacturing plant, if the CONTRACTOR so chooses. If possible, the visit shall be prior to or during the manufacturing of the geomembrane rolls for the specific project. The CONTRACTOR or his designated representative shall review the manufacturing process, quality control, laboratory facilities, and testing procedures.

During the visit, visiting personnel will also:

- a. Confirm that the measurements of properties by the Manufacturer are properly documented and test methods used are acceptable.

- b. Spot inspect the rolls and confirm that they are free of holes, blisters, or any sign of contamination by foreign matter.
- c. Review packaging and transportation procedures to confirm that these procedures are not damaging the geomembrane.
- d. Confirm that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, and roll number.
- e. If applicable, confirm that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

The Geomembrane Manufacturer shall accommodate these activities.

2.3.5 Conformance Testing

2.3.5.1 Tests. Prior to shipment of the rolls of geomembrane, the CQA Subcontractor shall obtain samples at a frequency of one per production lot or one per 4,645 square meters (50,000 square ft) of geomembrane, whichever results in the greater number of tests. The CQA Subcontractor will test the samples to determine conformance to both the design specifications and the list of guaranteed properties.

As a minimum, tests to determine the following characteristics will be performed on geomembranes:

- a. Specific gravity (ASTM D1505/D792).
- b. Carbon black content and visual inspection to evaluate carbon black dispersion (ASTM D1603 / D4218 and ASTM D5596).
- c. Thickness (ASTM D5199 or D5994 as applicable).
- d. Tensile characteristics (yield strength, elongation at yield, break strength, elongation at break ASTM D6693).
- e. Puncture Resistance (ASTM D4833).
- f. Friction angle of textured geomembrane with soil liner material (ASTM D5321).
- g. Seam Strength, if applicable (ASTM D6392).

Where optional procedures are noted in the test method, the requirements of these Specifications will prevail.

2.3.5.2 Sampling Procedures. Samples will be taken across the entire width of the roll and will not include the first 1 meter (3 ft). Unless otherwise specified, samples will be 1 m (3 ft) long by the roll width. The machine direction on the samples shall be marked with an arrow.

2.3.6 Fabrication Quality Control

Factory panel fabrication, if any, shall be in accordance with the applicable sections of these Technical Specifications for field panel placement and seaming.

2.3.7 Transportation, Handling, and Storage

Transportation of the geomembrane shall be the responsibility of the SUBCONTRACTOR. Handling on site shall be the responsibility of the SUBCONTRACTOR.

Upon delivery at the site, the SUBCONTRACTOR and the CQA Subcontractor shall observe the surfaces of rolls or factory panels for defects and for damage. This inspection shall be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Subcontractor will determine:

- a. Rolls, factory panels, or portions thereof, which shall be rejected and removed from the site because they do not meet requirements.
- b. Rolls or factory panels which include repairable flaws.
- c. Rolls or factory panels that are not properly labeled. No unlabelled rolls shall be used for any application. Unlabelled rolls shall be removed from the site and replaced at the SUBCONTRACTOR's expense.

The SUBCONTRACTOR shall be responsible for storage and protection of the geomembrane. Geomembrane rolls shall be stored on a prepared subgrade free of rocks and graded to drain away from stored materials.

2.4 GEOTEXTILES

2.4.1 Types of Geotextiles

- a. Type A geotextile shall be 0.27 kg/m^2 (8 oz/yd^2) nominal weight and shall be used for separation of operations and drainage layers in the landfill, in the geocomposite drainage layer, and at other locations as shown on the Drawings.
- b. Type B geotextile shall be 0.54 kg/m^2 (16 oz/yd^2) nominal weight and shall be used for cushioning of geomembranes on the landfill floor and at other locations as shown on the Drawings.

Geotextiles, regardless of type, shall be nonwoven, needlepunched polypropylene.

2.4.2 Manufacturer

The Geotextile Manufacturer shall have a minimum of five years of experience as a commercial manufacturer of geotextiles for landfill applications.

2.5 GEOTEXTILE PROPERTIES

2.5.1 Property Values

Geotextile properties shall meet or exceed the values specified in the table titled "Required Geotextile Properties".

The Manufacturer shall provide test results for properties listed in the Referenced Table

The Manufacturer shall certify that the materials supplied meet the requirements of this Subcontract.

2.5.2 Integrity

Geotextiles shall retain their structure during handling, placement, and long-term service.

2.6 GEOTEXTILE CONFORMANCE TESTING

Prior to shipment or after delivery of the rolls of geotextile, the CQA Subcontractor shall obtain samples at a frequency of one per production lot or one per 4645 m² (50,000 square ft) of each material type, whichever results in the greater number of tests. The CQA Subcontractor will test the samples to determine conformance to both the design specifications and the list of certified properties.

At a minimum, the following tests will be performed on geotextiles (each type):

- a. Mass per unit area (ASTM D5261)
- b. Grab strength (ASTM D4632)
- c. Tear strength (ASTM D4533)
- d. Puncture strength (ASTM D4833)
- e. Thickness (ASTM D1777 or D5199)
- f. Permittivity (ASTM D4491) Type A only
- g. AOS (ASTM D4751) Type A only

2.7 GEOTEXTILE, HANDLING, AND STORAGE

Geotextiles shall be supplied in rolls wrapped in protective dust-proof covers and marked or tagged with the following information:

- a. Manufacturer's name.
- b. Product identification.
- c. Lot number.
- d. Roll number.
- e. Roll dimensions.

Transportation of the geotextiles to the site and handling on site shall be the responsibility of the SUBCONTRACTOR.

During shipment and storage, the geotextile shall be protected from mud, dirt, dust, puncture, cutting, moisture, or other damaging or deleterious conditions. Geotextile shall be stored on a prepared subgrade free of rocks graded to drain away from stored materials.

The SUBCONTRACTOR shall be responsible for the storage and protection of the geotextiles. Geotextile stockpile shall be covered with a tarp to protect from all sunlight, dust, and precipitation.

2.8 GEOCOMPOSITES

The work includes manufacture, fabrication (if needed), supply, and installation of geocomposite drainage layers. The geocomposite will consist of a layer of geotextile thermally bonded to each side of a geonet. Requirements for geotextiles are contained in Section 2.4 GEOTEXTILES, of these Specifications. Requirements for geonets and the finished geocomposite are contained in this section.

2.8.1 Composition

The geonet shall be high density polyethylene (HDPE).

The geocomposite shall consist of Type A geotextile 100% thermally bonded to each side of the HDPE geonet.

2.8.2 Manufacturer

The Geocomposite Manufacturer shall have a minimum of five years experience as a commercial manufacturer of geocomposites for landfill drainage applications.

2.9 GEOCOMPOSITE PROPERTIES

2.9.1 Geonet

Geonet properties shall meet or exceed the values specified in the table titled "Required Geonet Properties".

2.9.2 Geotextile

Geotextile properties shall meet or exceed the values specified in the referenced table.

2.9.3 Manufacturer's Certification

The Manufacturer shall provide specification sheets, literature and test results for properties listed in these Specifications.

The Manufacturer shall certify that the materials supplied meet the requirements of this Technical Specification.

2.9.4 Integrity

Geonets and Geocomposites shall retain their structure during handling, placement, and long-term service. Unbonded areas of geotextile to geonet shall be subject to rejection.

2.10 GEOCOMPOSITE CONFORMANCE TESTING

Prior to shipment of the rolls of geonet and geocomposite, the CQA Subcontractor will obtain samples at a frequency of one per production lot or one per 4,645 m² (50,000 square ft) of each material type, whichever results in the greater number of tests, except that only two (2) friction angle tests on each interface will be performed. The CQA Subcontractor will test the samples to determine conformance to both the Technical Specifications and the list of certified properties.

Tests on geonets and geotextiles to be used for the geocomposite shall be performed prior to geocomposite fabrication. Geocomposite fabricated from non-conforming components shall be rejected at the SUBCONTRACTOR's expense. Geotextiles shall be tested in accordance with requirements for Type A Geotextile.

As a minimum, the following tests will be performed on geonets:

- a. Polymer specific gravity (ASTM D1505)
- b. Thickness (ASTM D5199)
- c. Mass per unit area (ASTM D5261)

As a minimum, the following tests will be performed on geocomposites:

- a. Ply Adhesion (ASTM D7005)
- b. Transmissivity (ASTM D4716)

2.11 GEOCOMPOSITE, HANDLING, AND STORAGE

Geocomposite shall be fabricated prior to transporting and shall be supplied in rolls wrapped in protective dust-proof covers and marked or tagged with of the following information:

- a. Manufacture's name.
- b. Product identification.
- c. Lot number.
- d. Roll number.
- e. Roll dimensions.

Transportation and handling of the geocomposite will be the responsibility of the SUBCONTRACTOR. Geocomposites shall be stored on a prepared subgrade, free of rocks, and graded to drain away from stored materials.

During shipment and storage, the geocomposite shall be protected from mud, dirt, dust, puncture, cutting, moisture, or other damaging or deleterious conditions.

The SUBCONTRACTOR shall be responsible for the storage and protection of the geocomposite materials. Geocomposite stockpile shall be covered with a tarp to protect from all sunlight, dust and precipitation.

2.12 GEOSYNTHETIC PENETRATIONS

Materials for Geosynthetic penetrations shall be in conformance to ASTM D6497.

3.0 EXECUTION

3.1 GENERAL

3.1.1 Unacceptable Materials and Work

Materials and work that fail to meet the requirements of the Subcontract shall be removed and disposed of at the SUBCONTRACTOR's expense.

3.1.2 Personnel Qualifications

3.1.2.1 Installer Organization. At a minimum, the Geosynthetics Installer shall have successfully completed at least 10 projects consisting of installation of at least 929,000 m² (10,000,000 ft²) (total) of HDPE liner. Projects shall include Resource Conservation and Recovery Act (RCRA) landfills and surface impoundments.

Seaming Personnel. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests similar to those described in this Technical Specification. The superintendent and lead welder foreman shall have experience seaming a minimum of 185,000 m² (1,991,000 ft²) of polyethylene geomembrane using the same type of seaming apparatus proposed for use on this project. These individuals shall provide direct supervision over less experienced seamers. No field seaming shall take place without one of these individuals being present in the cell area.

Key personnel are defined as the superintendent, foreman, and lead welder. Key personnel shall be full time employees of the Geosynthetics Installer.

Training and qualification procedures and records shall be submitted to the CONTRACTOR.

3.1.3 Applicability

Geosynthetic materials shall be installed at the locations, lines and grades shown on the Drawings. Liners shall be installed in accordance with the Subcontract.

3.1.4 Installation Plan

The SUBCONTRACTOR shall submit a plan describing the proposed methods for unloading, storage, deployment, panel layout, seaming, testing, repair, and protection. This shall include the type and weight of any equipment proposed for deployment and detailed methodology for installation over existing admix and geosynthetics to prevent damage.

3.2 ANCHOR TRENCH EXCAVATION AND BACKFILLING

The anchor trench shall be excavated to the lines and widths shown on the Drawings, prior to geosynthetics installation. All areas in contact with the geomembrane shall be rounded with a minimum 150mm (6 in) radius so as to avoid sharp bends in the geosynthetic. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. All CQA and CQC activities shall continue through the anchor trench.

Geosynthetics shall be anchored as shown on the Drawings. The backfill material and placement method shall be as described in Specification 0600X-SP-C0072.

3.3 GEOMEMBRANE PLACEMENT - HDPE GEOMEMBRANE

3.3.1 Field Panel Identification

A field panel is the unit area of geomembrane that is to be seamed in the field.

- a. A field panel is a roll or a portion of roll cut in the field that is in intimate contact with the underlying material (as opposed to a patch).

The CQA Subcontractor and SUBCONTRACTOR shall agree on a numbering system and assign each field panel an "identification code" consistent with the layout plan. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers assigned in the manufacturing plant are usually cumbersome and are not related to location in the field.)

The CQA Subcontractor will establish a table or chart showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for CQC and CQA.

3.3.2 Field Panel Placement

3.3.2.1 Location. Field panels shall be installed at the locations indicated in the SUBCONTRACTOR layout plan, approved by the CONTRACTOR with white side up.

3.3.2.2 Installation Schedule. Panels deployed shall be continuously welded the same day deployed.

3.3.2.3 Geomembrane Handling and Placement

- a. The SUBCONTRACTOR shall handle geomembranes in such a manner as to ensure it is not damaged.
- b. In the presence of wind, exposed geomembrane shall be weighted with ultraviolet resistant sandbags or as approved. Sandbags shall be installed during placement and shall remain until replaced with cover material. CONTRACTOR's equipment shall not be used to weight down geomembranes.
- d. Geomembranes shall be cut using an approved geomembrane cutter only. Underlying geosynthetic materials shall not be damaged during cutting.
- e. After installation, the geomembrane shall be examined over its entire surface to ensure that no potentially harmful foreign objects, such as needles, rocks, debris, etc are present. Any foreign objects encountered shall be removed.
- g. Vehicles will not be permitted on geomembrane unless approved by CONTRACTOR.

3.3.3 Placement Conditions

Geomembrane placement shall not proceed at an ambient temperature below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F) as measured 300 mm (12 inches) above the geomembrane surface, unless otherwise authorized by the CONTRACTOR. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., snow, ice, fog, dew), in an area of ponded water, or in the presence of winds over 20 mph. Placement methods shall prevent damage to underlying admix or geosynthetic materials. Driving directly on any geosynthetic layer is not allowed, unless approved in advance by the CONTRACTOR as part of the installation plan.

3.3.4 Damage

The SUBCONTRACTOR and the CQA Subcontractor shall inspect each panel, after placement and prior to seaming, for damage. The CQA Subcontractor will advise the SUBCONTRACTOR which panels, or portions of panels, shall be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected shall be removed from the work area. Repairs shall be made according to procedures approved by the CONTRACTOR.

3.4 FIELD SEAMING

3.4.1 Seaming Equipment and Products

Double-wedge fusion welding shall be used for field seaming geomembrane panels. Extrusion welding shall be limited to repairs and tie-ins. Proposed alternate processes shall be documented and submitted to the CONTRACTOR for approval. Only equipment that has been specifically approved by make and model shall be used.

3.4.1.1 Extrusion Process. The extrusion-welding machine shall be equipped with gages capable of measuring the temperature at the nozzle or the preheat temperature.

The SUBCONTRACTOR shall provide documentation regarding the extrudate to the CQA Subcontractor and shall certify that the extrudate is compatible with these Specifications and is comprised of the same resin type as the geomembrane sheeting.

The SUBCONTRACTOR shall comply with the following:

- a. Maintain a sufficient number of spare operable seaming machines (at least two spare extrusion seaming machines) on site to ensure continuous operation. Spare parts and consumables also shall be maintained on site.
- b. The equipment used for seaming shall not damage the geomembrane.
- c. The extruder shall be purged prior to beginning a seam until heat-degraded extrudate has been removed from the barrel.
- d. Seaming machine and support equipment (electric generators, miscellaneous tools, etc.) shall be placed on a smooth geomembrane rub sheet base such that no damage occurs to the geomembrane.
- e. Grinding shall be completed no more than 1 hour prior to seaming.
- f. A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.
- g. The geomembrane shall be protected from damage.

3.4.1.2 Fusion Process. The fusion-welding machines shall be automated self-propelled devices. The fusion-welding machines shall be equipped with gauges giving the applicable temperatures.

The SUBCONTRACTOR shall comply with the following:

- a. Maintain a sufficient number of spare operable seaming machines (at least two spare fusion seaming machines) on site to ensure continuous operations. Spare parts and consumables also shall be maintained on site.
- b. The equipment used for seaming shall not damage the geomembrane.
- c. The seaming machine and support equipment (electric generators, compressors, vacuum pumps, miscellaneous tools, etc.) shall be placed on a smooth geomembrane rub sheet base such that no damage occurs to the geomembrane.
- d. A smooth insulating plate of fabric shall be placed beneath the hot welding machine after usage.
- e. The geomembrane shall be protected from damage.
- f. A movable protective layer may be used directly below each overlap of geomembrane to be seamed to prevent buildup of moisture between the sheets. At no time can this protective layer be left in place.

3.4.2 Seam Layout

The SUBCONTRACTOR shall provide the CONTRACTOR and the CQA Subcontractor with a seam layout drawing, i.e., a drawing of the facility to be lined showing expected seams. The CQA Subcontractor will review the seam layout drawing and confirm that it is consistent with accepted state of practice. No panels shall be seamed in the field without the CONTRACTOR's approval. No panels not specifically shown on the seam layout drawing shall be used without the CONTRACTOR's prior approval.

In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope and over laps shall be shingled down the slope. In corners and odd-shaped geometric locations, the number of seams shall be minimized. On the landfill floor, no horizontal seam shall be less than 1.52 m (5 ft) from the toe of the slope, or other area of potential stress concentrations, unless otherwise authorized by the CONTRACTOR. The geomembrane shall not have horizontal seams on the side slopes.

Seams shall be aligned to produce the fewest possible number of wrinkles and "fishmouths."

A seam numbering system consistent with the panel numbering system shall be established by the CQA Subcontractor and SUBCONTRACTOR 30 days prior to liner installation. This system shall be submitted to the CONTRACTOR.

3.4.3 Weather Conditions for Seaming

The allowable weather conditions for seaming are as follows:

- a. Unless authorized in writing by the CONTRACTOR, no seaming shall be attempted at ambient temperatures below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F) as measured 300 mm (12 inches) above the liner. The CQA Subcontractor will confirm that these weather conditions are fulfilled and will advise the SUBCONTRACTOR if they are not. The CONTRACTOR will then decide if the installation will be postponed or if modified procedures shall be used.
- b. The geomembrane shall be dry, protected from wind, and free of dust.

If the Installer wishes to use methods that will allow seaming at ambient temperatures below 0 degrees C (32 degrees F), the SUBCONTRACTOR shall certify in writing that the quality of the seams welded at these temperatures is the same as the quality of seams welded at temperatures above 0 degrees C (32 degrees F) as measured 300mm (12 inches) above the geomembrane surface, unless otherwise authorized by the CONTRACTOR. In addition, if the SUBCONTRACTOR wishes to seam at ambient temperatures below 0 degrees C (32 degrees F) the following conditions shall be satisfied in addition to the general seaming procedures:

- a. For extrusion welding, preheating shall be performed. Preheating may be waived, if it is demonstrated to the satisfaction of the CQA Subcontractor that welds of equivalent quality may be obtained without preheating.
- b. Preheating equipment shall be approved by the CONTRACTOR prior to use.
- c. Sheet grinding, if required, may be performed before preheating.
- d. The CQA Subcontractor will observe areas of the geomembrane that have been preheated to determine if subjected to excessive melting.
- e. The SUBCONTRACTOR and CQA Subcontractor shall confirm that geomembrane surface temperatures have not decreased below the minimum specified for welding, due to wind or other adverse conditions. Wind protection for the seam area may be required by the SUBCONTRACTOR.
- f. Trial seams shall be made in the immediate area where seaming will occur, under the same subgrade and same ambient temperature and preheating conditions as the actual seams. New trial seams shall be made if the ambient temperature

decreases by more than 3 degrees C (5 degrees F) from the previous trial seam conditions. Such new trial seams shall be conducted at the end of the seam in progress during the temperature drop.

- g. Additional destructive seam tests may be performed by the SUBCONTRACTOR at the CQA Subcontractor's discretion.
- h. The SUBCONTRACTOR shall test sample coupons cut from each end of the seam. The CQA Subcontractor will observe the installer testing these coupons in the field.
- i. Testing required by these Specifications or the CQA Plan shall also be performed on seams fabricated at temperatures below 0 degrees C (32 degrees F).

3.4.4 Seam Preparation

3.4.4.1 Cleaning. Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. Special attention shall be paid to cleaning the existing geomembrane at tie-in locations. Cleaning shall not damage the liner.

3.4.4.2 Overlap. Cross slope seams on both the trench floor and sidewalls shall be overlapped so that liquids are not trapped, i.e., seams shall be shingled downslope.

If seam overlap grinding is required, the process shall be completed according to the Geomembrane Manufacturer's instructions within one hour of the seaming operation and not damage the geomembrane. SUBCONTRACTOR shall submit procedures to perform seam grinding.

Panels of geomembrane shall have a finished overlap as recommended by the manufacturer. However, in any event sufficient overlap shall be provided to allow peel and shear tests to be performed on the seam.

3.4.4.3 Use of solvents. No solvent or adhesive shall be used.

3.4.4.4 Temporary Bonding. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

3.4.5 General Seaming Procedures

The general seaming procedure used by the SUBCONTRACTOR shall be as follows:

- a. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

- b. A firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
- c. If seaming operations are carried out at night, 5 foot-candles of lighting is required by OSHA and shall be provided by SUBCONTRACTOR for workers as well as the CONTRACTOR and CQA Subcontractor.
- d. "Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed, and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 150 mm (6 in.) beyond the cut in each direction.
- e. When seaming of the geomembrane liner has been completed and prior to placing overlying materials, the CQA Subcontractor will observe the geomembrane for wrinkles. The SUBCONTRACTOR and CQA Subcontractor will indicate which wrinkles shall be cut and seamed or otherwise repaired by the SUBCONTRACTOR. The resulting seam(s) shall be tested like any other seam.
- f. Geomembrane in sump areas shall be installed and tested. Extreme care shall be taken while welding around appurtenances since neither nondestructive nor destructive testing may be feasible in these areas. The Installer shall ensure that the geomembrane is not visibly damaged during installation.

3.5 GEOMEMBRANE SEAM TESTING

Training and qualification procedures and records shall be submitted to the CONTRACTOR.

SUBCONTRACTOR shall submit vacuum, air, and non destructive testing procedures for CONTRACTOR approval.

Testing records shall be maintained by the SUBCONTRACTOR and be available for CQA Subcontractor and CONTRACTOR inspection.

3.5.1 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Trial seams shall be made at the beginning of each seaming period, and at least once each four hours, for each seaming machine and operator used that day. This frequency may be increased at the direction of the CQA Subcontractor. Trial seams shall be made under the same conditions and on the same subgrade as actual seams.

Trial welds shall be conducted for different material types. (i.e. smooth to smooth, smooth to textured and textured to textured)

The trial seam sample shall be at least 0.61 m (2 ft) long by 0.30 m (1 ft) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in this Technical Specification

Four adjoining specimens, each 25 mm (1 in.) wide, shall be cut from the trial seam sample by the SUBCONTRACTOR. The specimens shall be alternately tested in shear and peel using a field tensiometer, and they shall not fail in the seam. If a specimen fails, the entire trial seaming operation for the failed configuration shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved. Records of trial seam testing shall be maintained by the SUBCONTRACTOR and be available for CQA Subcontractor and CONTRACTOR inspection.

Test equipment shall be in calibration and conform to manufacturer's specifications. The SUBCONTRACTOR shall provide the CONTRACTOR with current calibration certificates.

3.5.2 Nondestructive Seam Continuity Testing

3.5.2.1 General. The SUBCONTRACTOR shall nondestructively test field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described below. The purpose of the nondestructive test is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be done as the seaming work progresses.

Any seams that fail nondestructive testing shall be repaired in accordance with these Specifications. Seams that cannot be nondestructively tested because of seam geometry shall be double welded or capped. Records of repair seam testing shall be maintained by the SUBCONTRACTOR and be available for CQA Subcontractor and CONTRACTOR inspection.

Test equipment shall be in calibration and conform to manufacturer's specifications. The SUBCONTRACTOR shall submit current calibration certificates.

3.5.2.2 Vacuum Testing (ASTM D5641). The equipment shall be comprised of the following:

- a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gage.
- b. A steel vacuum tank and pump assembly equipped with a pressure controller and connections.
- c. A rubber pressure/vacuum hose with fittings and connections.
- d. A bucket and wide paint brush.

- e. A soapy solution.

The following procedures shall be used:

- a. Energize the vacuum pump and reduce the tank pressure to a minimum of 127 mm (5 in.) of mercury.
- b. Wet a strip of geomembrane approximately 0.30 m (12 in.) wide by 1.2 m (48 in.) long with the soapy solution. The soapy solution shall not dry before the area is vacuum tested.
- c. Place the vacuum box over the test area.
- d. Close the bleed valve and open the vacuum valve.
- e. Ensure that a leak tight seal is created.
- f. For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
- g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 76 mm (3 in.) overlap, and repeat the process.
- h. Areas where soap bubbles appear shall be marked and repaired in accordance with the Technical Specifications.

3.5.2.3 Air Pressure Testing (ASTM D5820). The following procedures are applicable only to those processes that produce a double seam with an enclosed air channel. All double seams with an enclosed air channel shall be air pressure tested.

The equipment shall be comprised of the following:

- a. An air pump (manual or motor driven) capable of generating and sustaining a pressure of at least 276 kPa (40 psi).
- b. A rubber hose with fittings and connections.
- c. A sharp hollow needle, or other approved pressure feed device.
- d. A calibrated pressure gage in 6.9 kPa (1 psi increments) capable of reading pressures up to 40 psi.

The following procedures shall be used:

- a. Seal both ends of the seam to be tested.
- b. Insert needle with pressure gauge, or other approved pressure feed device, into the air channel created by the fusion weld.
- c. Energize the air pump and pressurize the channel to a minimum of 207 kPa (30 psi). Close the valve and sustain the pressure for a minimum of 5 minutes.
- d. If loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with this section. If, in the judgment of the CQA Subcontractor, significant changes in geomembrane temperature occur during the test (e.g., due to cloud cover), the test shall be repeated after the geomembrane temperature has stabilized.
- e. Cut end of seam opposite to the pressure gage and observe that the pressure drops. If the pressure does not drop, locate the obstruction(s) in the seam, repair, and retest seam.
- f. Remove needle or other approved pressure feed device and repair seam.
- g. Gauges shall be calibrated annually, at the project beginning, and at the discretion of the CONTRACTOR.

3.5.3 Destructive Seam Strength Testing

3.5.3.1 General. Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses. The samples shall meet the requirements of the table titled "Required Seam Properties".

Test equipment shall be in calibration and conform to manufacture's specifications. The SUBCONTRACTOR shall submit current calibration certificates.

3.5.3.2 Location and Frequency. The CQA Subcontractor will select locations where seam samples shall be removed for laboratory testing by the SUBCONTRACTOR.

Sampling frequency shall be a minimum of one sample per 152 m (500 ft) of seam length per welding machine per day (this minimum frequency shall be determined as an average taken from the panels, including welds for caps), or a minimum of two samples per factory panel, whichever gives the largest number of samples. This frequency may be increased at the discretion of the CQA Subcontractor or CONTRACTOR.

3.5.3.3 Sampling Procedures. Samples shall be cut by the SUBCONTRACTOR as the seaming progresses to provide laboratory test results before completion of installation. The SUBCONTRACTOR shall assign a number to each sample, mark it accordingly, and record the sample location on the layout drawing.

Holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures. The continuity of the new seams in the repaired area shall be tested as described in this Technical Specification.

3.5.3.4 Sample Size. The samples shall be 300 mm (12 in.) wide by 1,060 mm (42 in.) long with the seam centered lengthwise. One 25 mm (1 in.) wide strip shall be cut from each end of the samples, and these shall be tested in the field as described below. The remaining sample shall be cut into three parts and distributed as follows:

- a. One portion to the SUBCONTRACTOR for laboratory testing at his discretion, 300 mm x 300 mm (12 in. x 12 in.).
- b. One portion to the CONTRACTOR for archive storage, 300 mm x 300 mm (12 in. x 12 in.).
- c. One portion to the CQA Subcontractor for laboratory testing, 300 mm to 400 mm (12 in. x 16 in.).

3.5.3.5 Field Testing. The two 25 mm (1 in.) wide strips described above shall be tested in the field by tensiometer for peel and shear and shall not fail in the seam if any test sample fails to pass, then the procedures outlined below (Procedures for Destructive Test Failure) shall be followed.

The CQA Subcontractor will mark samples and portions with their number. The CQA Subcontractor will also record the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail descriptions, and attach a copy to each sample portion.

3.5.3.6 Procedures for Areas Failing Destructive Tests. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the CQA Laboratory, the SUBCONTRACTOR's laboratory, or by field tensiometer. The SUBCONTRACTOR has two options:

- a. Cap the seam between any two passing test locations, or
- b. Trace the seam to two intermediate locations 3.0 m (10 ft) minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full samples shall be taken for CQA laboratory testing. If these laboratory samples pass the tests, then the seam shall be capped between these locations if either

sample fails, then the sampling and testing process shall be repeated to establish the zone over which the seam shall be capped.

When possible all acceptable capped seams shall be bounded by two locations from which samples passing CQA laboratory destructive tests have been taken. If all welding for one a machine has been capped, it is not always possible to get a passing sample. The CQA Subcontractor will decide whether or not taking a sample from the capping seam for destructive testing is warranted.

3.6 REPAIRS

3.6.1 General

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. Repairs shall be conducted in accordance with this technical specification and shall be subjected to the nondestructive seam testing procedures.

Each patch or other type of repair shall be numbered and recorded and documentation shall be reviewed and approved by the CQA Subcontractor.

SUBCONTRACTOR training and qualification procedures and records shall be submitted to the CONTRACTOR.

SUBCONTRACTOR shall submit repair procedures for CONTRACTOR approval.

Repair records shall be maintained by the SUBCONTRACTOR and be available for CQA Subcontractor and CONTRACTOR inspection.

Repairs are to be performed at the SUBCONTRACTOR's expense.

3.6.2 Repair Procedures

Several procedures exist for repair. The decision as to the appropriate repair procedure, materials, and equipment shall be agreed upon in advance between the SUBCONTRACTOR, and CQA Subcontractor. Potentially acceptable procedures include:

- a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- b. Grinding and rewelding, used to repair small sections (typically with a maximum length of no more than several inches) of extruded seams.
- c. Spot welding or seaming used to repair pinholes or other minor, localized flaws.
- d. Capping, used to repair large lengths of failed seams.

- e. Topping, used to repair areas of inadequate seams, which have an exposed edge.
- f. Removing bad seam and replacing with a strip of new material welded into place, used with large lengths of fusion seams.

For repair methods, the following provisions shall be satisfied as applicable:

- a. Surfaces of the geomembrane that are to be repaired by extrusion welding shall be abraded no more than one hour prior to the repair.
- b. Surfaces shall be clean and dry at the time of the repair.
- c. Patches or caps shall extend at least 150 mm (6 in.) beyond the edge of the defect, and each corner of a patch or cap shall be rounded with a radius of at least 75 mm (3 in.).
- d. The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

3.6.3 Verification of Repairs

Each repair shall be numbered and recorded. Each repair shall be nondestructively tested using the methods described in this Technical Specification. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the CQA Subcontractor. Repairs that fail nondestructive or destructive tests shall be redone and retested until a passing test is obtained. The CQA Subcontractor shall observe non-destructive testing of repairs and will record the number of each repair, date, and test results. CQA Subcontractor will determine if destructive samples are required on any repairs.

3.7 MATERIALS IN CONTACT WITH GEOMEMBRANE

Requirements of this section apply to geomembranes that are directly in contact with overlying soil or are covered with a layer of geotextile or geocomposite.

The requirements of this section are intended only to assure that the installation of other materials does not damage the geomembrane. Additional requirements as established in other sections of these specifications are to assure that systems built with these other materials are constructed in such a way as to provide proper performance.

3.7.1 Temperature

Do not place granular materials on the geomembrane at ambient temperatures below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F) as measured 300mm (12 inches) above the geomembrane surface.

3.7.2 Minimum Thickness

Equipment used for placing granular material shall not be driven directly on the geomembrane. A minimum thickness of 0.30 m (1 ft) of granular material shall be maintained between placement equipment and the geomembrane. A minimum thickness of 0.91 m (3 ft) of granular material shall be maintained between rubber-tired hauling vehicles and the geomembrane.

3.7.3 Spreading Equipment

Equipment used for placing or spreading granular material shall be as specified in 0600X-SP-C0069.

3.7.4 Spreading Operations

Equipment used for spreading granular material shall be as specified in 0600X-SP-C0069. Placement of operations layer soil materials on the geomembrane will not be allowed within 15 m (50 ft) of any unseamed edge of geomembrane.

3.8 LINING SYSTEM ACCEPTANCE

The SUBCONTRACTOR shall retain ownership of and responsibility for the lining system until acceptance by the CONTRACTOR.

The geosynthetic lining system will be accepted by the CONTRACTOR when the following requirements have been satisfied:

- a. The installation is finished.
- b. Verification of the adequacy of field seams and repairs, including associated testing is complete.
- c. A written construction report, including "as built" drawings and installation documents and CQC documents have been prepared by the CQA Subcontractor, sealed by a registered professional engineer, and approved by the CONTRACTOR.
- d. The requirements of the GENERAL CONDITION titled FINAL INSPECTION AND ACCEPTANCE have been satisfied.
- e. SUBCONTRACTOR records, submittals, etc. are provided.

3.9 GEOTEXTILES

3.9.1 Installation Plan

The SUBCONTRACTOR shall submit a plan describing the proposed methods for geotextile unloading, storage, deployment, panel layout, seaming, testing, repair, and protection. The plan shall include a quality assurance program (training, qualifications, procedures, records, oversight/peer review, etc.) for the SUBCONTRACTOR's activities related to geotextile installation.

Materials and work that fail to meet the requirements of this specification section for geotextiles shall be removed and disposed of at the SUBCONTRACTOR's expense. This includes geotextile rolls that are not labeled or where the label has deteriorated to the point of being illegible.

3.9.2 Geotextile Handling and Placement

- a. The SUBCONTRACTOR shall handle geotextiles in such a manner as to ensure that they are not damaged. Do not drag the geotextile across textured geomembrane. If necessary, use a smooth slip sheet under the textile. Position the geotextile after deployment and remove the slip sheet, if used.
- b. Place geotextiles in a manner that prevents folds and wrinkles. Folds or wrinkles shall be pulled smooth prior to seaming.
- c. In the presence of wind, exposed geotextiles shall be weighted with ultraviolet resistant sandbags or as approved. Sandbags shall be installed during placement and shall remain until replaced with cover material.
- d. Geotextiles shall be cut using an approved geotextile cutter only. Underlying geosynthetic materials shall not be damaged during cutting.
- e. During geotextile placement, stones, excessive dust, or moisture that could damage the geomembrane, clog drains or filters, or hamper subsequent seaming shall be removed.
- f. After installation, the geotextile shall be examined over its entire surface to ensure that no potentially harmful foreign objects, such as needles, rocks, debris, etc are present. Any foreign objects encountered shall be removed.
- g. Vehicles shall not be permitted on the geotextile unless approved by CONTRACTOR.
- h. If light colored geotextile is used, precautions shall be taken against "snowblindness" of personnel.

- i. After deployment, geotextile shall be covered to prevent exposure to ultraviolet (UV) radiation (sunlight) within a maximum period of 14 calendar days 2 weeks.

3.9.3 Seaming

- a. Geotextiles shall be overlapped a minimum 75 mm (3 in.) prior to seaming.
- b. Geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Alternatively, single or double wedge fusion welding will be acceptable. The CQA requirements for welding will be the same as for sewing. Leister welding (spot or continuous) will not be accepted as a replacement for sewing.
- c. On the landfill floor, no horizontal seam shall be closer than 0.9 m (3 ft) to the toe of the slope or other areas of potential stress concentrations unless authorized in writing by the CONTRACTOR.
- d. Areas to be seamed shall be clean and free of foreign material.
- e. Sewing shall be done using polymeric thread with chemical resistance properties equal to or exceeding those of the geotextile, or as approved by the CONTRACTOR.
- f. Sewing shall be done using a sewing machine that creates a chain stitch. When entering and exiting a seam, the stitches shall be overlapped to prevent unraveling.
- e. SUBCONTRACTOR training and qualification procedures for sewing shall be submitted to the CONTRACTOR.

3.9.4 Geotextile Repair

Any holes or tears in the geotextile shall be repaired as follows:

- a. Remove any soil or other material that may have penetrated the torn geotextile.
- b. A patch made from the same geotextile shall be double seamed into place with the seams 6.4 to 19 mm (1/4 in. to 3/4 in.) apart and no closer than 25 mm (1 in.) from any edge. The patch shall extend at least 12 inches beyond the edges of the damaged area. Seaming shall be in accordance with paragraph 3.9.3 of this section.

3.9.5 Materials in Contact with Geotextiles

The SUBCONTRACTOR shall place soil materials located on top of a geotextile in such a manner as to ensure that the following conditions are satisfied:

- a. No damage to the geotextile.
- b. Minimal slippage of the geotextile on underlying layers.
- c. No excess tensile stresses in the geotextile.

3.10 GEOCOMPOSITES

Materials and work that fail to meet the requirements of these specifications shall be removed, disposed of, and replaced at the SUBCONTRACTOR's expense.

3.10.1 Installation Plan

The SUBCONTRACTOR shall submit a plan describing the proposed methods for geocomposite unloading, storage, deployment, panel layout, seaming, testing, repair, and protection. The plan shall include a quality assurance program (training, qualifications, procedures, records, oversight/peer review, etc.) for the SUBCONTRACTOR's activities related to geocomposite installation.

3.10.2 Handling and Placement

- a. The SUBCONTRACTOR shall handle geocomposites in such a manner as to ensure that these materials are not damaged.
- b. Clean geomembrane surface prior to placing geocomposite to remove dust, dirt and debris.
- c. On slopes, geocomposite may be deployed over slip-sheets with the roll at the top of the slope. An alternative method is to secure the geocomposite and then roll it down slope in a manner to continually keep it in tension if necessary, position the geocomposite after deployment to minimize wrinkles and remove the slip sheet, if used.
- d. Do not drag the geocomposite across textured geomembrane.
- e. In the presence of wind, exposed geocomposites shall be weighted with ultraviolet resistant sandbags or equivalent. Sandbags shall be installed during geocomposite placement and shall remain until replaced with cover material.
- f. Unless otherwise specified, geocomposites shall not be welded to geomembranes.
- g. Geocomposites shall only be cut using approved cutting tool.

- h. The SUBCONTRACTOR shall take necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- i. During placement of geocomposites, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane if dirt or excessive dust is entrapped in the geocomposite, it shall be cleaned prior to placement of the next material on top of it.
- j. Vehicles shall not be permitted on the geocomposite unless approved by CONTRACTOR.
- k. Tools shall not be left on or under the geocomposite.
- l. In geocomposites, tearing the geotextile away from the geonet shall not be allowed except at seam locations in corners as approved by the CQA Subcontractor.
- m. After deployment, geocomposite shall be covered to prevent exposure to ultraviolet (UV) radiation (sunlight) within a maximum period of 14 calendar days.

3.10.3 Joining

- a. Adjacent sections of geocomposite shall be overlapped according to manufacturer's directions.
- b. Overlaps shall be secured by tying. Acceptable tying devices include plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy observation. Metallic joining devices are not allowed.
- c. Overlaps shall be secured every 1.5 m (5 ft) along slopes and on the floor of the landfill. Along end-to-end seams, spot weld and tie 2 rows 75 mm (3 in.) apart. Spot weld and tie each row at 150 mm (6 in.) intervals; stagger weld or ties between rows.
- d. No horizontal seams shall be allowed on side slopes provided rolls can be manufactured to sufficient length. If required because of manufacturing limitation end seams shall be staggered.
- e. If more than one layer of geocomposite is installed, joints shall be staggered.
- f. Top geotextile component of the geocomposite shall be sewn.

3.10.4 Repair

- a. Remove the damaged or unbonded area of geocomposite.
- b. Cut a piece of geocomposite to fit over the repair area. Geocomposite shall fit over repair area and shall be tied similar to end to end seams.
- c. Remove any dirt or other foreign material that may have entered the geocomposite.
- d. Geocomposite damage greater than 4 sq ft shall require removal of full roll width of damaged area.

3.10.5 Materials in Contact with Geocomposites

The SUBCONTRACTOR shall place soil materials located on top of a geocomposite layer in such a manner as to ensure that the following conditions are satisfied:

- a. No damage to the geocomposite.
- b. No slippage of the geocomposite on underlying layers.
- c. No excess tensile stresses in the geocomposite.

Placement of soil materials shall begin at the bottom of side slopes and progress upslope or laterally at about the same elevation such that a full layer of material is covering the geosynthetics downslope from the area being covered.

3.11 GEOSYNTHETIC PENETRATIONS

Geosynthetic penetrations shall be installed per ASTM D6497.

3.12 QUALITY ASSURANCE/QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

Records shall include, but not be limited to the following:

- (1) Calibration of seaming and testing equipment. Calibration shall be at manufacturers' recommended intervals or whenever rough handling, damage, or other factors indicate that accuracy may have been compromised. Methods used for calibration shall conform

to manufacturers' recommendations. Secondary standards shall be traceable to national standards.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory shall be furnished to the CONTRACTOR within one working day following the inspection or test.

Table 1
High Density Polyethylene (HDPE) Geomembrane – 60 mil Textured

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values
Thickness (min. avg.) • Minimum individual	ASTM D5994	1 per Roll	60 mil 57 mil
Asperity Height (min. avg.)(1)	GRI GM -12	1 per 50,000 sf	20 mil
Sheet Density (min)	ASTM D792 or ASTM D1505	1 per 50,000 sf	0.949 g/cc
Tensile Properties (2) (min. avg.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693	1 per 50,000 sf	126 lb/in 90 lb/in 12% 110%
Tear Resistance (min. avg.)	ASTM D1004 Die C	1 per 50,000 sf	42 lbs
Puncture Resistance (min. avg.)	ASTM D4833	1 per 50,000 sf	90 lbs
Stress Crack Resistance (3)	ASTM D5397 (App.)	(12)	300 hours
Carbon Black Content (range)	ASTM D1603 (4)	1 per 50,000 sf	2-3%
Carbon Black Dispersion (5)	ASTM D5596	1 per 50,000 sf	Category 1,2,or 3 (5)
Oxidative Induction Time (OIT) (min. avg.) (6) • Std. OIT, or • High Pressure OIT	ASTM D3895 ASTM D5885	(11)	100 min. 400 min
Oven Aging at 85 C (6)(7) • Std OIT (min. avg.), % retained after 90 days or • High Pressure OIT (min. avg.), % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	(11)	55% 80%
UV Resistance (8) • Std. OIT (min. avg.), or • High Pressure OIT (min. avg.) % retained after 1600 hrs (10)	GRI GM -11 ASTM D3895 ASTM D5885	(11)	(9) 50%

- (1) Alternate the measurement side for double sided textured sheet
- (2) Machine direction (MD) and cross machine direction (XMD) average values shall be on the basis of 5 test specimens each direction.
 - Yield elongation is calculated using a gage length of 1.3 inches
 - Break elongation is calculated using a gage length of 2.0 inches.
- (3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test shall be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
- (4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2, and
 - 1 in Category 3.
- (6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
- (8) The condition of the test shall be 20 hr. UV cycle at 75 C followed by 4 hr. condensation at 60 C.
- (9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
- (10) UV resistance is based on percent retained value regardless of the original HP-OIT value.
- (11) Manufacturer may provide certification letter per resin formulation.

TABLE 2
High Density Polyethylene (HDPE) Geomembrane 100 Mil Smooth

Properties	Test Method	Manufacturer QC Test Frequency	Required Test Values
Thickness (min. avg.) • Minimum individual	ASTM D5199	1 per Roll	100 mil 97 mil
Sheet Density (min)	ASTM D792 or ASTM D1505	1 per 50,000 sf	0.940 g/cc
Tensile Properties ⁽¹⁾ (min. avg.) • Yield strength • Break strength • Yield elongation • Break elongation	ASTM D6693	1 per 50,000 sf	210 lb/in 380 lb/in 12% 700%
Tear Resistance (min. avg.)	ASTM D1004 Die C	1 per 50,000 sf	70 lbs
Puncture Resistance (min. avg.)	ASTM D4833	1 per 50,000 sf	180 lbs
Stress Crack Resistance ⁽²⁾	ASTM D5397 (App.)	(10)	300 hours
Carbon Black Content (range)	ASTM D1603	1 per 50,000 sf	2-3%
Carbon Black Dispersion ⁽⁴⁾	ASTM D5596	1 per 50,000 sf	Category 1,2, or 3 ⁽⁴⁾
Oxidative Induction Time (OIT) (min. avg.) ⁽⁵⁾ • Std. OIT, or • High Pressure OIT	ASTM D3895 ASTM D5885	(10)	100 min. 400 min.
Oven Aging at 85 C ⁽⁵⁾⁽⁶⁾ • Std OIT (min. avg.), % retained after 90 days or • High Pressure OIT (min. avg.), % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	(10)	55% 80%
UV Resistance ⁽⁷⁾ • Std. OIT (min. avg.), or • High Pressure OIT (min. avg.) % retained after 1600 hrs ⁽⁹⁾	GRI GM -11 ASTM D3895 ASTM D5885	(10)	(8) 50%

- (1) Machine direction (MD) and cross machine direction (XMD) average values shall be on the basis of 5 test specimens each direction.
 - Yield elongation is calculated using a gage length of 1.3 inches
 - Break elongation is calculated using a gage length of 2.0 inches.
- (2) The yield stress used to calculate the applied load for the SP_NCTL test shall be the manufacturer's mean value.
- (3) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
- (4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2, and
 - 1 in Category 3.
- (5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
- (7) The condition of the test shall be 20 hr. UV cycle at 75 C followed by 4 hr. condensation at 60 C.
- (8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
- (9) UV resistance is based on percent retained value regardless of the original HP-OIT value.
- (10) Manufacturer may provide certification letter per resin formulation.

**TABLE 3
REQUIRED SEAM PROPERTIES**

PROPERTY	QUALIFIER	UNIT	SPECIFIED VALUE ¹		TEST METHOD
<u>Physical Properties – Hot Wedge Seams</u>					
Thickness	Nominal	Mils	60	100	
Shear Strength ²¹ (at yield point)	Minimum	Lb/in width	120	200	ASTM D6392
Peel Adhesion	Minimum	Lb/in width	FTB ³² 91	FTB 151	ASTM D6392 ASTM D6392
			FTB	FTB	ASTM D6392
<u>Physical Properties – Extrusion Seams</u>					
Thickness	Nominal	Mils	60	100	
Shear Strength ²¹ (at yield point)	Minimum	Lb/in width	120	200	ASTM D6392
Peel Adhesion ⁴	Minimum	Lb/in width	FTB ³² 78	FTB 130	ASTM D6392 ASTM D6392
			FTB	FTB	ASTM D6392

1. Destructive testing shall meet specified values for all testing. Values from GRIGM-19
2. Also called "Bonded Seam Strength".
3. FTB = Film Tear Bond (failure occurs through intact geomembrane, not through seam).
4. No more than 25% of the seam width can separate (peel) to be considered a passing specimen.

TABLE 4
REQUIRED GEOTEXTILE PROPERTIES

PROPERTY	UNIT	VALUE (a)		TEST METHOD
		TYPE A	TYPE B	
Thickness	Mils	80	155	ASTM D1777 or D5199
Mass/Unit Area	oz/yd ²	8	16	ASTM D5261
Apparent Opening ^c Size (b)	U.S. Sieve	80		ASTM D4751
Grab Strength	Lb	220	390	ASTM D4632
Trapezoidal Tear Strength	Lb	95	150	ASTM D4533
Puncture Strength	Lb	120	240	ASTM D4833
Permittivity ^c	sec ⁻¹	1.5		ASTM D4491
UV Resistance (500 hours)	% strength retained	>70	>70	ASTM D4355

Notes: (a) All values are minimum average roll values.

(b) Out-of-range values will be reviewed and can be approved by the CONTRACTOR on a case-by-case basis.

(c) Not Required for Cushion Geotextile (Type B)

**TABLE 5
REQUIRED GEONET PROPERTIES**

GEONET				
PROPERTY	QUALIFIER	UNIT	VALUE	TEST
Polymer composition	Minimum	% polyethylene	95	--
Mass per Unit Area	MARV ⁽¹⁾	oz/yd ²	24	ASTM D5261
Polymer specific gravity	Minimum	N/A	0.94	ASTM D1505
Polymer melt index	Range	g/10 min	0.1-1.1	ASTM D1238
Carbon black content	Range	%	2 - 3	ASTM D1603 or D4218
Thickness	MARV	Mils	200 ⁽²⁾	ASTM D1777 or D5199

Notes:

- (1) MARV = Minimum Average Roll Value.
- (2) Represents minimum value, a thicker geonet may be required to meet transmissivity requirement of geocomposite.

TABLE 6
REQUIRED GEOCOMPOSITE PROPERTIES

TYPE A GEOCOMPOSITE				
PROPERTY	QUALIFIER	UNIT	VALUE	TEST
Transmissivity ⁽²⁾⁽³⁾	MARV ⁽¹⁾	m ² /sec	1 x 10 ⁻³	ASTM D4716
Ply Adhesion ⁽⁴⁾	Minimum	lb/in	1.0	ASTM D7005

Notes:

- (1) MARV = Minimum Average Roll Value.
- (2) Measured using water at 20°C (68°F) with a gradient of 0.1, under a compressive stress of 479 kPa (10,000 psf) between two smooth steel plates.
- (3) This transmissivity exceeds the regulatory requirement of 3x10⁻⁵ m²/
- (3) Certify there are no un-bonded areas for the geotextile to geonet.

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CELL CONSTRUCTION – LEACHATE COLLECTION SYSTEMS AND LYSIMETERS

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for the Leachate Collection System, Lysimeters, and Operation Layer of the Environmental Restoration Disposal Facility (ERDF) Cells 7 through 10.

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ASTM	American Society for Testing and Materials
API	American Petroleum Institute
CQA	Construction Quality Assurance
EPA	Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HDPE	High Density Polyethylene
CQC	Construction Quality Control
QAP	Quality Assurance Plan
SSRS	Subcontractor/Supplier Submittal Requirements Summary
IWCP	Integrated Work Control Program

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Leachate Collection System Construction. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Cell Construction. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kNm/m ³))
ASTM D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)

ASTM D4373	Standard Test Method for Rapid Determination of Carbonate Content of Soils
ASTM D4644	Standard Test Method for Slake Durability of Shales and Similar Weak Rocks
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
EPA/600/R-93/182	EPA, Technical Guidance Document, Quality Assurance and Quality Control for Waste Containment Facilities*
WAC 173 216	State Waste Discharge Permit Program
WAC 173 400	General Regulations for Air Pollution Sources
Washington DOT Standard Specification	

* Note that an update to EPA/600/R-93/182 has been published: Daniel, D.E. and Koerner, R. M. (2007). *Waste Containment Facilities: Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems*, second ed., ASCE, New York, NY, 351 pp.

1.4 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.4.1 Drainage Gravel Placement Plan

The SUBCONTRACTOR shall submit a placement plan describing the proposed methods and equipment for drainage gravel manufacturing or supply; delivery; stockpiling; testing; placement; compaction; and as-built surveying. The plan shall include a quality control program for the SUBCONTRACTOR's activities related to the protection of adjacent pipes, geosynthetic layers and installation activities (inspections, measurements, materials, etc.).

1.4.2 Operations Layer Placement Plan

The SUBCONTRACTOR shall submit a placement plan describing the proposed borrow source, methods, and equipment for operations layer placement, testing, compaction, and as-built surveying. The plan shall include a quality control program for the SUBCONTRACTOR's activities related to the protection of adjacent pipes, geosynthetic layers and installation activities (inspections, measurements, materials, etc.).

1.5 DESCRIPTION

This section includes the work for furnishing and installing the Drainage Gravel, and Operations Layer. The high density polyethylene (HDPE) pipe used as leachate collection piping on floor, cleanout access pipe on the slope, and sideslope sump riser pipes are included in specifications 0600X-SP-M0029 and 0600X-SP-M0030.

1.5.1 Drainage Gravel

This work consists of the supply and installation of gravel for the drainage layers and sumps in the ERDF cells.

1.5.2 Operations Layer

This work consists of the supply and installation of soil for the operations layer in the ERDF cells.

2.0 MATERIALS AND EQUIPMENT

Drainage gravel may be obtained from Pit 30 located north of the Construction Access Road approach on Route 3 as shown on Exhibit "F" drawings. Material from Pit 30 shall be excavated (existing stockpiles shall not be used) and processed to manufacture gravel meeting the specifications. SUBCONTRACTOR is responsible for traffic control and removal of mud, rocks, and debris across Route 3 during transport of gravel from Pit 30 to the project site.

2.1 DRAINAGE GRAVEL

2.1.1 Applicability

The following specifications apply to gravel in the primary and secondary leachate collection systems and the lysimeters.

2.1.2 Durability

Gravel shall consist of rounded material that is mechanically stable and chemically inert. In general, hard rock types such as basalt and granite are preferred; siltstones, mudstones, and carbonate rocks are not acceptable. The SUBCONTRACTOR shall perform slake durability ASTM D4644 and carbonate content tests ASTM D4373 on the gravel samples. A loss in weight of less than 3% will be considered acceptable.

2.1.3 Permeability

Gravel shall exhibit a permeability of 1×10^{-2} cm/sec (3.9×10^{-3} in/sec) or greater (ASTM D2434).

2.1.4 Samples

Submit gravel samples to the CONTRACTOR a minimum of two weeks prior to full scale production for testing in accordance with the CQA Plan.

2.2 DRAINAGE GRAVEL TYPE A

Type A gravel shall be used for drainage layers outside of the sump area. This material shall consist of rounded gravel meeting the following gradation requirements:

U.S. Sieve Size	% Passing
1-1/2 in.	100
1 in.	70-100
3/4 in.	60-100
3/8 in.	35-80
No. 4	20-60
No. 40	0-10
No. 100	0-4
No. 200	0-4

2.3 DRAINAGE GRAVEL TYPE B

Type B gravel shall be used for drainage inside of the primary and secondary sumps. This material shall consist of well-rounded gravel and meet the gradation requirements of Washington DOT standard specification 9-03.12(4) (ASTM C136)

U.S. Sieve Size	% Passing
1 in.	100
3/4 in.	80-100
3/8 in.	10-40
No. 4	0-4
No. 200	0-2

2.4 DRAINAGE GRAVEL TYPE C

Type C gravel shall be used for drainage inside of the lysimeter sump area. This material shall consist of crushed gravel meeting the following gradation requirements (ASTM C136):

U.S. Sieve Size	% Passing
1-1/2 in.	100
1 in.	70-100
3/4 in.	60-100
3/8 in.	35-80
No. 4	20-60
No. 40	0-10
No. 100	0-4
No. 200	0-4

2.5 OPERATIONS LAYER MATERIAL

Operations layer material shall consist of native, non-organic, granular soil derived from approved on-site sources with following USCS classifications: GM, GP, SW, SM, and SP, or as approved by the CONTRACTOR.

2.5.1 Composition

Soils shall be free of roots, wood, peat, cinders, frozen material, rubbish, or other deleterious material.

2.5.2 Particle Size

Soils shall have a maximum particle size of 100 mm (4 in.), provided large particles are in soil matrix (ASTM D422).

2.5.3 Compactability

Trench floor operations layer material shall be capable of being moisture conditioned and compacted to at least 90% of the maximum dry density as determined by the standard Proctor test (ASTM D 698).

2.5.4 Samples

Submit samples a minimum of two weeks prior to full scale production for testing in accordance with the CQA Plan.

3.0 EXECUTION

3.1 GENERAL

3.1.1 Unacceptable Materials and Work

Materials and work that fail to meet the requirements of these specifications shall be removed and disposed of at the SUBCONTRACTOR's expense. Repair/replacement shall be at the SUBCONTRACTOR's expense.

3.2 MATERIALS IN CONTACT WITH GEOSYNTHETICS

Requirements of this section apply to geomembranes that are directly in contact with overlying soil or are covered with a layer of geotextile or geocomposite.

The requirements of this section are intended to assure that the installation of other materials does not damage the geomembrane. Additional requirements as established in the Subcontract are to assure that systems built with these other materials are constructed in such a way as to provide proper performance.

3.2.1 Temperature

Do not place granular materials on the geosynthetics at ambient temperatures below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F) unless otherwise specified.

3.2.2 Minimum Thickness

Equipment used for placing granular material shall not be driven directly on the geosynthetics. A minimum thickness of 0.30 m (1 ft) of granular material shall be maintained between placement equipment and the geosynthetics. A minimum thickness of 0.91 m (3 ft) of granular material shall be maintained between rubber-tired hauling vehicles and the geosynthetics.

Equipment and minimum material thicknesses shall be closely monitored to verify that no loads exceed a ground contact pressure of more than 5 psi measured 300mm (12 inches) above the geosynthetics.

3.2.3 Hauling Equipment

No articulated trucks shall be used to haul granular material above the geosynthetics. Hauling operations above any geosynthetics shall be monitored to verify that appropriate material thicknesses are maintained.

3.2.4 Spreading Equipment

Equipment used for spreading material above any geosynthetics shall be a light ground pressure dozer with less than 5 psi contact pressure, or other equipment as approved.

3.2.5 Spreading Operations

Placement equipment operating on materials above geosynthetics shall not spin their wheels, make sharp turns, or make sharp, rapid stops. Good operating practice shall be used by spreading equipment. Specifically, no sharp turns, any abrupt starting or stopping, and no heavy loads using excavators. Materials shall be pushed carefully in an upward tumbling action from previously placed material and not dumped directly onto geosynthetics. Placement and spreading operations shall be continuously monitored by the SUBCONTRACTOR and the CONTRACTOR. Placement of soil materials on the geomembrane will not be allowed within 15 m (50 ft) of any unseamed edge of geomembrane.

3.2.6 Materials in Contact with Geocomposites

The SUBCONTRACTOR shall place granular materials and HDPE riser pipes located on top of a geocomposite layer in such a manner as to ensure that the following conditions are satisfied:

- a. No damage to the geocomposite.
- b. No slippage of the geocomposite on underlying layers.
- c. No excess tensile stresses in the geocomposite.

3.3 DRAINAGE GRAVEL PLACEMENT PLAN

Submit a plan describing the manufacturing or supply, delivery, stockpiling, testing, placement, production, compaction, and as-built survey procedures for drainage gravel placement.

3.3.1 Drainage Gravel Placement

- a. Load, handle, and place drainage gravel using equipment and methods that will minimize generation of fines.
- b. Place gravel over lysimeter, secondary and primary geosynthetic materials across base of landfill, and in sumps as shown on Drawings.
- c. Spread gravel layers with low ground pressure spreading equipment as specified.
- d. Hauling and placing equipment shall operate on a minimum of 3 feet of granular material above any geosynthetic layer. Grading equipment shall operate on no less than 0.30 m (1 ft) of gravel over any geosynthetic layer. In all cases, equipment and minimum material thicknesses shall be closely monitored to verify that no loads exceed a ground contact pressure of more than 5 psi measured 300mm (12 inches) above the geosynthetics.

3.3.2 Compaction

Drainage gravel shall be track walked in 0.30 m (1 ft) thick lifts by spreading equipment. Type C crushed drainage gravel shall be compacted to 90 percent of the maximum dry density as determined by ASTM D 698.

3.3.3 Protection

- a. Protect sump pipes, side slope riser pipes, perforated drain pipes, and other pipes and structures from damage.
- b. Do not use dozer or other vehicle to compact granular material within 0.46 m (1.5 ft) of perforated drain or collector pipes. In these locations, compact with a walk-along vibratory roller, powertamper, or other means approved by CONTRACTOR after full thickness of granular material has been placed.
- c. Protect underlying geosynthetics from damage. Drainage gravel shall be pushed carefully from previously placed material and not dumped directly onto geosynthetics.
- d. The SUBCONTRACTOR shall take steps to minimize wrinkle generation in underlying geosynthetic materials during placement of the drainage gravel. The measures may include placing gravel in the early morning hours when the geosynthetic materials are cool and monitoring and walking out wrinkles in the geosynthetic materials that appear at the edge of the placement area
- e. Do not place gravel over geomembrane or geosynthetics that have a "trampoline" effect due to low temperature shrinkage to prevent tearing seams. Allow liner material to warm and lay flat on substrate material before continuing spread of gravel layer.

3.4 OPERATIONS LAYER PLACEMENT PLAN

Submit a plan describing the manufacturing or supply, delivery, stockpiling, testing, placement, production, compaction, and as-built survey procedures for the operations layer.

3.4.1 Operations Layer Placement

- a. Place operations layer over geosynthetic materials on base and side slopes of landfill as shown on Drawings. Place and compact in one lift to minimize potential damage to the liner.
- b. Do not place operations layer until final inspection of geosynthetics by the CONTRACTOR has been made to verify that conditions stated in the CQC Plan are satisfied.
- c. Hauling and placing equipment shall operate on a minimum of 0.9 m (3 ft) of material above any geosynthetic layer.

- d. Grading equipment shall operate on no less than 0.9 m (3 ft) of operations layer material over any geosynthetic layer. In all cases, equipment and minimum material thicknesses shall be closely monitored to verify that no damage is done to the underlying liner system and no loads exceed a ground contact pressure of more than 5 psi measured 300mm (12 inches) above the geosynthetics.
- e. Operations layer material placed on the side slopes shall be pushed up from the bottom of the slope.
- f. In locations where heat seaming has been used to join geotextile sections, the operations layer shall be spread in the same direction as the seam overlap to avoid placing additional stress on the seam.

3.4.2 Compaction

The finished surface of the operations layer on the trench floor shall be compacted to 90% of the maximum dry density as determined by the standard Proctor test (ASTM D698) and shall be capable of supporting rubber-tired vehicles with minimum degradation to the working surface.

3.4.3 Protection

- a. Protect underlying geosynthetics from damage.
- b. The SUBCONTRACTOR shall take steps to minimize wrinkle generation in underlying geosynthetic materials during placement of the operations layer. The measures may include placing operations layer material in the early morning hours when the geosynthetic materials are cool, and monitoring and walking out wrinkles in the geosynthetic materials that appear at the edge of the placement area.
- c. Avoid placement of operations layer soils over any area of geomembrane with “trampoline” effect. Allow liner to warm and lay flat on substrate before continuing spreading operation.

3.5 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Control Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

- (1) Control of overall drainage gravel layer thickness. Drainage gravel elevations shall be determined by surveying on a minimum 15.24 m (50 ft) grid and at grade breaks over the floor and side slopes of the disposal trench except that detailed surveying shall be required in the sump area and other locations to establish grade breaks and slope continuity as directed by the CONTRACTOR. Vertical survey accuracy shall be plus or minus 15 mm (0.05 ft) or better. Results shall be provided to the CONTRACTOR. No liner materials shall be installed on the finished surface until satisfactory thickness of the drainage layer has been verified.
- (2) Control of overall operations layer thickness. Operations layer elevations shall be determined by surveying on a minimum 15.24 m (50 ft) grid and at grade breaks over the floor and side slopes of the disposal trench except that detailed surveying shall be required in the sump area and other locations to establish grade breaks and slope continuity as directed by the CONTRACTOR. Vertical survey accuracy shall be plus or minus 15 mm (0.05 ft) or better. Results shall be provided to the CONTRACTOR.

Copies in duplicate of these surveys, records and other test results, as well as records of corrective actions taken to obtain satisfactory installations and satisfactory results, shall be furnished to the CONTRACTOR within one working day following the inspection, survey, or test.

SPECIFICATION FOR

DOCUMENT CONTROL mjp 10/11/07

REINFORCED CONCRETE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF) CELLS 7, 8, 9, & 10 CONSTRUCTION

WASHINGTON CLOSURE HANFORD		JOB NO. 14655	
SUPPLIER/SUBCONTRACTOR DOCUMENT STATUS STAMP			
1. <input checked="" type="checkbox"/> Work may proceed. 2. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission. 3. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission subject to resolution of indicated comments. 4. <input type="checkbox"/> Revise and resubmit. Work may not proceed. 5. <input type="checkbox"/> Permission to proceed not required.			
Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the supplier/subcontractor and does not relieve supplier/subcontractor from full compliance with contractual obligations or release any "holds" placed on the contract.			
	CIVIL MECHANICAL ARCHITECTURAL GEOTECHNICAL	ELECTRICAL	MECHANICAL
	PROCESS NUCLEAR	CADD	PROJECT REP.
			ENVIRONMENTAL
			WASTE MANAGEMENT
			SAFETY
			INDUSTRIAL HYGIENE
			FIRE PROTECTION
			QA
			PLACON
			FIELD ENGINEER
			OTHER
CHECK REVIEW REQUIREMENT			✓
REVIEWED BY		BB	
Bill Borlaug Project Engineer/STR		10/9/07 Date	
DOCUMENT ID NUMBER			
0600X-SC-60524 05-18		004	
SC/P.O. No.		SSRS ITEM	
SUBMITTAL			



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Rev.	Date	Reason for Revision	Originator	Checker	Project Engineer	LEAD Design Eng.
0	9/28/07	Issued for Construction	MF	RFW	SCR	DC7
Washington Closure Hanford, LLC		RIVER CORRIDOR CLOSURE CONTRACT	Job No. 14655 Specification No. 0600X-SP-C0070 Page 1 of 27			

REINFORCED CONCRETE

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REINFORCED CONCRETE

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for Reinforced Concrete.

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ACI	American Concrete Institute
ASTM	American Society for Testing and Materials
CRSI	Concrete Reinforcing Steel Institute
FS	Federal Specifications
NRMCA	National Ready-Mixed Concrete Association
AHA	American Hardboard Association
DOC	Department Of Commerce
CQC	Construction Quality Control QAP Quality Assurance Program
SSRS	Subcontractor/Supplier Submittal Requirements Summary

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Reinforced Concrete. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Reinforced Concrete. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ACI 117	Standard Specification for Tolerances for Concrete Construction and Materials
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	Standard Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting

ACI 318	Building Code Requirements for Structural Concrete
ACI 347R	Guide to Formwork for Concrete
ASTM A 615	Standard Specification for Deformed and Plain Carbon -Steel Bars for Concrete Reinforcement
ASTM A 675	Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality, Mechanical Properties
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 578	Standard Specification for Rigid, Preformed, Cellular Polystyrene Thermal Insulation
ASTM C 591	Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 597	Standard Test Method for Pulse Velocity through Concrete
ASTM C 618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 803	Standard Test Method for Penetration Resistance of Hardened Concrete
ASTM C 805	Standard Test Method for Rebound Number of Hardened Concrete
ASTM C 989	Standard Specification for Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTMC 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D-98	Standard Specification for Calcium Chloride
ASTM E 96	Standard Test methods for Water Vapor Transmission of Materials
CRSI MSP-1	Concrete Reinforcing Steel Institute, Manual of Standard Practice
FS CCC-C-467	Cloth, Burlap, Jute (or Kenaf)
NRMCA CPMB 100	Concrete Plant Standards

NRMCA QC 3	Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready-Mixed Concrete Production Facilities
NRMCA TMMB	Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards
AHA A135.4	Basic Hardboard
DOC PS 1-95	Construction and Industrial Plywood

1.4 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor/Supplier Submittal Requirements Summary (SSRS) Submittals that do not meet requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.4.1 Shop Drawings

Detail drawings showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

1.4.2 Mix Design

The Mix Design shall comply with the requirements of ACI 318. If production facility strength records are utilized as basis for mix design the data shall be submitted. If a new mix design is formulated the mix design records and test results shall be submitted. Batch weights, constituents, suppliers, and quality control data shall be submitted for each concrete mix design. Mix design submittals shall be submitted at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition.

1.4.3 Testing

Submit copies of test reports.

1.5 GENERAL REQUIREMENTS

Tolerances for concrete construction and materials shall be in accordance with ACI 117.

1.5.1 Strength Requirements

Structural concrete shall have a 28-day compressive strength of 27.59 MPa (4000 psi). Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

1.5.2 Air Entrainment

Concrete shall contain from 5 to 7 percent total air, except where hard trowel finish is planned where the air content shall be less than 3 percent.

1.5.3 Special Properties

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved by the CONTRACTOR.

1.5.4 Slump

Slump shall be within the following limits:

<u>Structural Element</u>	<u>Minimum</u>	<u>Maximum</u>
Walls, columns and beams 4 in.	2 in.	4 in.
Foundation walls, substructure walls, footings, pavement, and slabs	2 in.	4 in.
Any structural concrete approved for placement by pumping	None	6 in.

Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

1.6 PROPORTIONS OF MIX

1.6.1 Mixture Proportioning, Normal Weight Concrete

Concrete mix designs shall be based on the requirements of ACI 318. If the required facility strength records are not available trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 318. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each mix design at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39.

1.6.2 Average Strength

Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 6.9 MPa (1000 psi) of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be:

- a. The specified strength plus 8.3 MPa (1200 psi) for specified strengths of 20.7 to 34.5 MPa (3000 to 5000 psi).

1.7 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weather-tight buildings, bins, or silos that will exclude moisture and contaminants. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements.

2.0 PRODUCTS

2.1 ADMIXTURES

Admixtures shall conform to the following:

- 2.1.1 Accelerating Admixture: ASTM C 494, Type C.
- 2.1.2 Air-Entraining Admixture: ASTM C 260.
- 2.1.3 High Range Water Reducer Admixture (Superplasticizers):

ASTM C 1017, Type 1 or 2.

- 2.1.4 Water-Reducing or Retarding Admixture:

ASTM C 494, Type A, B, D, F, or G.

2.2 CEMENTITIOUS MATERIALS

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

- 2.2.1 Cement: ASTM C 150, Type I or II.
- 2.2.2 Portland-Pozzolan Cement: ASTM C 595, Type IP.
- 2.2.3 Fly Ash: ASTM C 618, Class F.

Pozzolan may be blended with Type I or II portland cement. When a pozzolan is used in a flexural strength concrete mix design, the solid volume of pozzolan when combined with Portland cement shall not exceed 25 percent of the weight of cementitious materials. Only one class of pozzolan, from a single source, shall be used.

- 2.2.4 Ground Granulated Blast Furnace Slag (GGBFS):

ASTM C989 Grade 100 or 120. GGBFS shall not exceed 50 percent of the total weight of cementitious materials.

2.3 AGGREGATES

Aggregates shall conform to the following:

- 2.3.1 Normal Weight Aggregate

ASTM C 33. Grading requirement for coarse aggregate shall conform to size number 57. Aggregate for Portland cement concrete shall comply with the WSDOT specifications for Aggregates for Portland cement concrete.

2.4 CURING MATERIALS

- 2.4.1 Burlap

FS CCC-C-467.

- 2.4.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.4.3 Membrane-Forming Compounds

ASTM C 309, Type 1-D, Class A or B.

2.5 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated on drawings or as needed for the application. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

2.6 NONSHRINK GROUT

Nonshrink grout shall conform to ASTM C 1107 Grade C and shall be a formulation suitable for the application.

2.7 WATER

Water shall be potable, except that nonpotable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

2.8 CONCRETE REINFORCEMENT

2.8.1 Reinforcing Steel

Reinforcing steel shall be deformed bars conforming to ASTM A 615 grade 60 with sizes as indicated.

2.8.2 Wire Ties

Wire ties shall be 16 gauge or heavier black annealed steel wire.

2.8.3 Supports

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI MSP-1 and shall be steel or precast concrete blocks. Precast concrete blocks shall have wire ties and shall be not less than 75 by 75-mm (3 x 3 in.) square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 13 mm (1/2 in.) of concrete surface shall be galvanized, plastic protected or of stainless steel. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast

concrete blocks; plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic

2.9 FORM MATERIALS

2.9.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.9.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used.

2.9.3 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 6 mm (1/4 in.) nor more than 25 mm (1 in.) deep and not more than 25 mm (1 in.) in diameter. Removable tie rods shall be not more than 38 mm (1-1/2) in. in diameter.

2.9.4 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

3.0 EXECUTION

3.1 PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

3.1.1 Foundations

Earthwork shall be as specified in the Technical Specification 0600X-SP-C0072 for Site Work. Flowing water shall be diverted without washing over freshly deposited concrete. Semiporous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 150 mm (6 in.) of the in-place pervious material or by covering with an impervious membrane.

3.1.2 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.2 INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated on drawings and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3.3 BATCHING, MIXING AND TRANSPORTING CONCRETE

Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and non-agitating units shall comply with NRMCA. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA or WSDOT.

3.3.1 Admixtures

Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added as recommended by manufacturer. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

3.3.2 Control of Mixing Water

No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch except when on arrival at the jobsite, and the slump of the concrete is less than that specified. Water added to bring the slump within the specified range shall not change the total water in the concrete to a point that the approved water-cement ratio is exceeded. The drum shall be turned an additional 30 revolutions, or more, if necessary, until the

added water is uniformly mixed into the concrete. Water shall not be added to the batch at any later time.

3.4 SAMPLING AND TESTING

Sampling and Testing is the responsibility of the SUBCONTRACTOR and shall be performed by an approved testing agency.

3.4.1 Aggregates

Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33. Gradation tests shall be performed on the first day and every other day thereafter during concrete construction.

3.4.2 Sampling of Concrete

Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.

3.4.2.1 Air Content. Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test per day shall be conducted and one for each set of compressive strength specimen.

3.4.2.2 Slump. At least 1 slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete placement and one slump test shall be performed for each set of compressive strength specimen cast. Tests shall be performed in accordance with ASTM C 143.

3.4.3 Evaluation and Acceptance of Concrete

3.4.3.1 Frequency of Testing. Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 100 cubic yards of concrete, nor less than once for each 450 square ft of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.4.3.2 Testing Procedures. Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.

3.4.3.3 Evaluation of Results. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square in.

3.4.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square in., or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the CONTRACTOR to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the CONTRACTOR to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried [temperature 16 to 27 degrees C, (60 to 80 degrees F), relative humidity less than 60 percent] for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the CONTRACTOR in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the CONTRACTOR. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the CONTRACTOR, at the expense of the SUBCONTRACTOR.

3.5 CONVEYING CONCRETE

Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph CONCRETE PLACEMENT by methods which will prevent segregation or loss of ingredients.

3.5.1 Chutes.

When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

3.5.2 Buckets

Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3.5.3 Belt Conveyors

Belt conveyors may be used when approved. Belt conveyors shall be designed for conveying concrete and shall be operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar. Conveyors shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

3.5.4 Pumps

Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy-duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.6 CONCRETE PLACEMENT

Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by the CONTRACTOR if the concrete is of such slump after the 1-1/2 hour time or 300-revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 29 degrees C, (85 degrees F), the time shall be reduced to 45 minutes. Concrete in excess of 90 degrees F shall not be placed under any circumstances. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

3.6.1 Placing Operation

Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the SUBCONTRACTOR prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 2.5 m (8 ft) except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 300 mm (12 in. thick), except that slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3.6.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 100 mm (4 in.) thick or less. The vibrators shall be adequate in effectiveness and number to properly consolidate the concrete: a spare vibrator shall be kept at the jobsite during concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150-mm (6 in.) into the preceding layer if there is such.

Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 100 mm (4 in.) and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

3.6.3 Cold Weather Requirements

Special protection measures in accordance with ACI 306R, approved by the CONTRACTOR, shall be used if the three day average of average daily temperature is less than 40F. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 4 degrees C (40 degrees F). The temperature of the concrete when placed shall be not less than 10 degrees C (50 degrees F) or more than 24 degrees C (75 degrees F). Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, chemical admixture conforming to ASTM C 494 Type C or E may be used. Calcium chloride shall not be used in concrete in any circumstance ..

3.6.4 Hot Weather Requirements

The temperature of the concrete placed during warm weather shall not exceed 29 degrees C (85 degrees F) except where a CONTRACTOR approved retarder is used. The mixing water and aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed 33 degrees C (90 degrees F). Other placement operations shall be in accordance with ACI 305R.

3.7 CONSTRUCTION JOINTS

Construction joints shall be located as indicated on drawings or approved. Where weather, end of work shift or other similar type of delay interrupts concrete work, location and type of construction joint shall be subject to approval of the CONTRACTOR. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown.

3.8 FINISHING CONCRETE

3.8.1 Formed Surfaces

Repair of Surface Defects. Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 25 mm (1 in.), whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by the CONTRACTOR and finished slightly higher than the surrounding surface. For Class A and Class B finished surfaces, the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material and ambient air shall be above 10 degrees C (50 degrees F) while making repairs and during the curing period. Concrete with defects that affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed.

3.8.1.1 Class A Finish. Where a Class A finish is indicated, fins shall be removed. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a 0.600 mm (No. 30 sieve), with water added to give the consistency of thick paint, shall be prepared. White cement shall be used to replace part of the job cement. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously

applied to the area by clean burlap pads or by cork or wood-floating, to completely fill surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads until all visible grout film is removed. The rubbing pads shall have on their surfaces the same sand-cement mix specified above but without any mixing water. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours. The temperature of the air adjacent to the surface shall be not less than 10 degrees C (50 degrees F) for 24 hours prior to, and 46 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas.

3.8.1.2 Class B Finish. Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.

3.8.1.3 Class C Finish. Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.

3.8.2 Unformed Surfaces

In cold weather, the air temperature in areas where concrete is being finished shall not be less than 10 degrees C (50 degrees F). In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 1 kg per square meter per hour (0.2 pounds per square foot per hour); coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 8 mm (5/16 in.) when tested with a 3.05 m (10-foot) straightedge. Floor tolerance measurements shall be made as soon as possible after finishing. When forms or shoring are used the measurements shall be made prior to their removal. Surfaces shall be pitched to drains.

3.8.2.1 Float Finish. Slabs to receive a steel trowel finish and slabs to be given a float finish shall be incidated. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Lightweight concrete or concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections. Care shall be exercised not to increase the bleed water while finishing the loading/unloading slab.

3.8.2.2 Light Broomed Finish. Float finish as noted above. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks. Then draw fine-hair broom lightly across surface. Broom in same direction and parallel to expansion joints or in the case of inclined slabs, perpendicular to the slope.

3.8.2.3 Finish Schedule

<u>Concrete Surface</u>	<u>Finish Type</u>
Vertical Exterior Exposed	Class A
Vertical Unexposed	Class C
Vertical Interior Exposed	Class B
Crest Pad Building Slab	Float

3.9 CURING AND PROTECTION

3.9.1 General

Concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement	3 days
Concrete with Type I, II, IP or IS cement	7 days
Concrete with Type I or Type II cement blended with pozzolan	7 days

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 10 degrees C (50 degrees F) for the first 3 days and at a temperature above 0 degrees C (32 degrees F) for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

3.9.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces that are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by pending, by covering with a 50 mm (2-in.) minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3.9.3 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete.. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be re-sprayed by the method and at the coverage specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.10 SETTING BASE PLATES AND BEARING PLATES

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 20 mm (3/4 in.). Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

3.10.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

3.10.2 Nonshrink Grout

Nonshrink grout shall be mixed and placed in accordance with material manufacturer's written recommendations. Forms of wood or other suitable material shall be used to retain the grout. The grout shall be placed quickly and continuously, completely filling the space without segregation or bleeding of the mix.

3.10.3 Treatment of Exposed Surfaces

For mortars or grouts, exposed surfaces shall be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

3.11 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318/318R. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on exposed ends of vertical concrete reinforcement bars in accordance with OSHA requirements. Wire tie ends shall face away from the forms.

3.11.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete. Reinforcement shall be placed in accordance with ACI 318/318R at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318/318R. If bars are moved more than 50 mm (2 in.) to avoid interference with other reinforcement, conduits, or embedded items, additional reinforcement shall be added.

3.11.2 Splicing

Splices of reinforcement shall conform to ACI 318/318R and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 150 mm (6 in.). Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.12 CONCRETE FORMWORK

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface that meets the requirements of the class of finish specified in Table 1. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

3.12.1 Storage and Handling

Fiber voids shall be stored above ground level in a dry location. Fiber voids shall be kept dry until installed and overlaid with concrete.

3.12.2 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified herein and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects that would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.12.3 Chamfering

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.12.4 Coating

Forms for Class A and Class B finished surfaces shall be coated with a form-releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather, with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.12.5 Removal Of Forms

Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test

strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

**TABLE 1
TOLERANCES FOR FORMED SURFACES**

1.	Variations from the plumb:		
	a. In the lines and surfaces of columns piers, walls and in arises	In any 3 m (10 ft) of length Maximum for entire length	6 mm (1/4 in) 25 mm (1 in)
	b. For exposed comer columns, control-joint grooves, and other conspicuous lines	In any 6 m (20 ft) of length Maximum for entire length	6 mm (1/4 in) 13 mm (1/2 in)
2.	Variation of the linear building lines from established position in plan	In any 6 m (20 ft) Maximum	13 mm (1/2 in) 25 mm (1 in)
3.	Variation of distance between walls, columns, partitions	6 mm (1/4 in) per 3 m (10 ft) of distance, but not more than 13 mm (1/2 in) in any one bay, and not more than 25 mm (1 in) total variation	
4.	Variation in the sizes and locations of sleeves, floor openings, and wall opening	Minus Plus	6 mm (1/4 in) 13 mm (1/2 in)
5.	Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus Plus	6 mm (1/4 in) 13 mm (1/2 in)
6.	Footings:		
	a. Variation of dimensions in plan	Minus Plus when formed or plus 75 mm (3 in) when placed against unformed excavation	13 mm (1/2 in) 50 mm (2 in)
	b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement, but not more than 50 mm (2 in)	50 mm (2 in)
	c. Reduction in Thickness	Minus	5 percent of specified thickness

3.13 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall submit to CONTRACTOR records of his quality control for operations including but not limited to the following:

- (1) Concrete Cylinder Strength Tests.
- (2) Test For Concrete Air Entrainment.
- (3) Concrete Slump Tests.
- (4) Check delivered material against approved shop drawings.
- (5) Inspection of location and spacing of bars.
- (6) Inspection of forms for adequate bracing.
- (7) Check form dimensions, and elevations for conformance to Subcontract documents.
- (8) Periodic inspection of condition of forms.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the CONTRACTOR within 1 working day of the inspection or test.

CREST PAD BUILDING

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CREST PAD BUILDING

1.0 GENERAL

1.1 SUMMARY

This specification establishes requirements for the Crest Pad Building.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meaning:

AAMA	American Architectural Manufacturers' Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
APA	American Plywood Association
AWPA	American Wood Preservers Association
AWS	American Welding Society
DOC	Department of Commerce
IBC	International Building Code
ICBO	International Conference of Building Officials
MBMA	Metal Building Manufacturer's Association
MSDS	Material Data Safety Sheet
NFOPA	National Forest Products Association
NFPA	National Fire Protection Association
PS	U.S. Department of Commerce-Product Standards
SDI	Steel Door Institute
UL	Underwriters Laboratories, Inc.
QAP	Quality Assurance Program
SSRS	Subcontractor/Supplier Submittal Requirements Summary

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for the Crest Pad Building. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to the Crest Pad Building. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

AAMA 605.2	Voluntary Specifications for High Performance Organic Coatings on Architectural Extrusions and Panels
AAMA 606.1	Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum
APA	APA: Grades and Specifications
AISC 360	Specifications for Structural Steel Buildings
AISC S329	Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts
AISC S348	LRFD Specification for Structural Joints Using ASTM A325 or A490 Bolts
AISC	Quality Certification Program
AISC D803	Steel Design Guide Series 3 - Serviceability Design Considerations for Low-Rise Buildings
AISI SG-671/2	Specification for the Design of Cold-Formed Steel Structural Members
ANSI A156.1	Butts and Hinges (BHMA 101)
ANSI A156.2	Bored and Preassembled Locks & Latches (BHMA 601)
ANSI A156.4	Door Controls - Closers (BHMA 301)
ANSI A156.13	Mortise Locks & Latches (BHMA 621)
ANSI A156.18	Materials and Finishes (BHMA 1301)
ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A490	Standard Specification for Structural Bolts, Alloy Steel Heat-Treated, 150 ksi Minimum Tensile Strength

ASTM A529/A529M	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A792/A792M	Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM C962	Standard Guide for Use of Elastomeric Joint Sealants
ASTM C991	Standard Specification for Flexible Glass Fiber Insulation for Metal Buildings
ASTM C1048	Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass
ASTM D 2898	Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials
ASTM E1514	Standard Specification for Structural Standing Seam Steel Roof Panel Systems
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
AWPA C2	Lumber, Timbers, Bridge Ties and Mine Ties Preservative Treatment by Pressure Processes
AWPA C20	Structural Lumber - Fire-Retardant Treatment by Pressure Processes
AWS D1.1	Structural Welding Code - Steel

AWS D1.3	Structural Welding Code - Sheet Steel
DOE-STD-1066-99	Fire Protection Design Criteria
IBC	International Building Code (IBC).
MBMA	Low Rise Building Systems Manual
NFPA 101	Life Safety Code (for egress, stairs, handrails, etc.)
NFPA 255	Standard Method of Test for Surface Burning Characteristics of Building Materials
PRP-108	Performance Standards and Policies for Structural-Use Panels
PS	PS 1, Construction and Industrial Plywood.SDI 100 Recommended Specifications, Standard Steel Doors and Frames
SDI 100	Recommended Specifications, Standard Steel Doors and Frames
UL 580	Tests for Uplift Resistance of Roof Assemblies
UL 723	Standard for Test for Surface Burning Characteristics of Building Materials

1.4 SYSTEM DESCRIPTION

- A. Complete building package using manufacturer's standard components/accessories and components/accessories as specified and noted on the Drawings.
- B. Primary Framing System: Clear span rigid frame
- C. Lateral Support System in Longitudinal Direction: Cross bracing, located as shown on Drawings
- D. Include: Doors, hardware, glazing, louvers, insulation and all sub-framing for door and louver openings.
- E. SUBCONTRACTOR shall provide and facilitate installation of items not provided by metal building manufacturer including, but not limited to, metal studs, tracks and accessories specified in the Technical Specifications for Metals and Wood products specified herein.

1.5 DESIGN REQUIREMENTS

- A. Applicable Building Code: The 2006 International Building Code (IBC) as amended by the State of Washington and local agencies.
- B. Snow Load:
1. Ground Snow Load (P_g): 10 pounds per square foot.
 2. Flat Roof Snow Load, (P_f): 11.0 pounds per square foot
 3. Exposure Coefficient (C_e): 0.9
 4. Snow Load Importance Factor (I): 1.10
 5. Thermal Factor, (C_t): 1.10
- C. Minimum Roof Live Load: 20 pounds per square foot.
- D. Building system dead load.
- E. Mechanical and Electrical Equipment Loads:
1. Purlins and Secondary Framing: As indicated on Drawings, minimum 10 pounds per square foot.
 2. Primary Frames: As indicated on Drawings, minimum 5 pounds per square foot.
- F. Wind Load:
1. Basic Wind Speed: 85 miles per hour.
 2. Exposure Category: C
 3. Wind Load Importance Factor (I): 1.15
 4. Internal Pressure Coefficient, (GC_{pi}): ± 0.18
- G. Earthquake Load:
1. Seismic Importance Factor, (I) = 1.25
 2. Occupancy Category: III.
 3. Mapped Spectral Response Accelerations, $S_S = 0.47$ $S_1 = 0.15$
 4. Site Class: D
 5. Spectral Response Coefficients: $S_{DS} = 0.451$, $S_{D1} = 0.20$
 6. Seismic Design Category: C
 7. Seismic Force Resisting System
 - N-S Ordinary Steel Moment Frame
Response Modification Factor, (R): = 3.5
Seismic Response Coefficient, (CS): = 0.161
 - E-W Ordinary Steel Concentrically Braced Frame

Response Modification Factor, (R): =3.25
Seismic Response Coefficient, (CS): =0.173

H. Deflection Criteria:

1. In accordance with the applicable provisions of the AISC D803 Steel Design Guide Series 3 - Serviceability Design Considerations for Low-Rise Steel Buildings.
2. Applies to primary and secondary framing members, bracing members, roof panels, and wall cladding.

I. Design Standards:

1. AISC 360 Specification for Structural Steel Buildings.
2. AISC S348 Specification for Structural Joints Using ASTM A325 or A490 Bolts.
3. AISI SG-671/2 Specification for the Design of Cold-Formed Steel Structural Members.
3. AWS D1.1, Structural Welding Code - Steel.

1.6 TECHNICAL SUBMITTALS

A. Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "T", Subcontractor/Supplier Submittal Requirements Summary (SSRS). . Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

B. Shop Drawings:

1. Manufacturer's literature and technical data.
2. Painting System: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats.
3. Structural Calculations Stamped by Registered Professional Engineer:
 - a. Complete analysis and design of structural components and connections in accordance with design requirements indicated.
 - b. Consider prying action of bolts for bolted moment-resistant connections in primary framing.
 - c. Design column bases as pinned, unless specifically indicated otherwise.
 - d. Mark out calculations that do not apply to specific Project.

4. **Drawings Stamped by Registered Professional Engineer:** Drawings shall be specifically prepared for this Project. Mark out details that do not apply to specific Project. Show design load criteria, material specifications for framing members and connections, roof framing plan with dimensions and member sizes, base plate details showing anchor bolt size and bolt layout, elevations of wall framing and bracing, instructions for temporary bracing, framing around roof and wall openings, details for joining and sealing of roof panels and wall cladding, and sections and details for all standard and non-standard components and accessories.
- C. **Samples:** Minimum 2-in. by 3-in. metal for components requiring color selection.
- D. **Informational Submittals:**
1. **Manufacturer's written instructions for shipping, handling, storage, protection and erection, or installation of building and components.**
 2. **Manufacturer:**
 - a. **Certification or proof of current membership in Metal Building Manufacturer's Association (MBMA).**
 - b. **AISC Quality Certification: AISC certificate showing name and address of manufacturer, effective date, and category of certification.**
 3. **Erector:**
 - a. **AISC Quality Certification: AISC certificate showing name and address of erector, effective date, and category of certification, or, in lieu of AISC certification, documentation of past 5 years' experience record to include project name, location, date of completion, building manufacturer, and name and phone number of OWNER's contact person.**
 - b. **Certification of approval by manufacturer.**
 4. **Manufacturer's Certificate of Proper Installation.**

1.7 QUALITY ASSURANCE

A. Qualifications:

1. **Designer:** Registered professional engineer valid in same state as Project.
2. **Manufacturer:**

- a. Current member of Metal Building Manufacturer's Association (MBMA).
- b. AISC Quality Certification: Metal Building Systems (MB).

3. Erector:

- a. AISC Quality Certification as Certified Steel Erector (CSE), or 5 years of experience in erection of metal building systems in lieu of AISC certification.
- b. Approval by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect building components and accessories from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Deliver to site with parts individually tagged.
- C. Store on wood blocking or pallets, flat and off ground, to keep clean and to prevent any damage or permanent distortion. Support bundles so there is no danger of tipping, sliding, rolling, shifting, or material damage. Cover with tarpaulins or other suitable weather tight ventilated covering.
- D. Protect finish of metal panels by application of removable plastic film or other suitable material placed between panels. Do not allow panels to come in contact with other material that would result in scratching, denting, staining or other damage to the panel finish.

1.9 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with CONTRACTOR named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of CONTRACTOR, removal and replacement of Work specified in this Specification section found defective during a minimum period of 5 years and as stated below after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.
- B. Conditions:
 - 1. Finish on metal roof and wall panels, flashing, and trim will not crack, check, blister, peel, flake, chip, or lose adhesion for 5 years.
 - 2. Roofing will remain weather tight for 20 years.

2.0 MATERIALS AND EQUIPMENT

2.1 BUILDING SYSTEM MANUFACTURERS

A. Products manufactured or supplied by the following, and meeting these Specifications, may be used on this Project:

1. American Buildings Company, Columbus, GA.
2. Behlen Manufacturing Co., Columbus, NE.
3. Bigbee Steel Buildings, Inc., Muscle Shoals, AL.
4. Butler Manufacturing Co., Kansas City, MO.
5. Ceco Corp., Columbus, MS.
6. Chief Industries, Inc., Grand Island, NE.
7. Garco Building Systems, Airway Heights, WA.
8. Metallic Building Co. Div., NCI Building Systems, Inc., Houston, TX.
9. Nucor Building Systems, Waterloo, IN.
10. Ruffin Building Systems, Oak Grove, LA.
11. Star Building Systems, a Robertson Ceco Co., Oklahoma City, OK.
12. Steelox Systems, Inc., Mason, OH.
13. United Structures of America, Inc., Houston, TX.
14. VP Buildings, Memphis, TN.
15. Whirlwind Building Systems, Houston, TX.

B. Building layout as shown on Drawings is based on products of Star Building Systems.

2.2 COMPONENTS

A. Structural Framing and Bracing:

1. Primary Framing: ASTM A36/A36M, A529/A529M, A572, or A992 with 3/16-in. minimum thickness and factory primer compatible with finish coating.
2. Secondary Framing: Steel for cold-formed galvanized channel and z-sections shall be ASTM A653/A653M, Structural Steel (SS) Grade 33 or High-Strength Low-Alloy Steel (HSLAS) Grade 50 Type A or B, with G60 galvanized coating and minimum design thickness equal to 0.0346 in.
3. Bracing:
 - a. ASTM A36/A36M or F1554, Grade 36, for threaded rod, or ASTM A36/A36M for rolled shapes.
 - b. Do not use wire rope or cable for permanent bracing.

4. Bolted Connections:

- a. Primary Framing: ASTM A325 or ASTM A490 high-strength bolted connections.
- b. Secondary Framing: ASTM A307 or ASTM A325.

B. Roof and Wall Panels:

1. Material

- a. ASTM A653/A653M or ASTM A792/A792M preformed ribbed steel panels, Grade 50, minimum.
- b. Minimum 24-gauge galvanized steel with roll-formed corrugations for structural stiffness and appearance.
- c. Finish: Polyvinylidene Fluoride : Kynar 500, two coats minimum in color shown or selected by CONTRACTOR.

2. Roof Panel System:

- a. ASTM E1514 structural standing seam steel roof panel system.
- b. Panels shall be one piece from eave to ridge, with concealed clips and fasteners to purlins to allow for thermal movement over 120-degree ambient temperature range.
- c. Side lap joints shall be made with a factory caulked, mechanically seamed cleat.
- d. Tested and certified to meet UL 580, Class 90 wind uplift rating.

3. Wall Panel System:

- a. One-piece from eave to sill, with base trim at sill.
- b. Side laps: Interlocking ribs with concealed fasteners.

4. Interior Wall and Ceiling Coverings:

- a. Exposed interior walls and ceilings (including ceilings formed by the underside of roofs), and any factory-installed facing material, should have a

UL-listed/FM-approved flame spread rating of 25 or less and a smoke developed rating of 50 or less, per DOE-STD-1066-99, Section 9.3.1.

2.3 ACCESSORIES

A. Hollow Metal Doors, Frames, and Glazing:

1. Furnish pressed steel frames and full flush hollow metal doors meeting Steel Door Institute (SDI) 100, Grade II, Model 1, 18 gauge.

a. See Door and Hardware Schedule on Drawings for tabulation of door and frame characteristics.

2. Glazing:

a. Tempered Flat Glass (kind HS and FT): ASTM C1048, clear tempered flat glass, 6 mm minimum thickness.

b. Ancillary materials as required.

B. Hardware Materials:

1. General:

a. Furnish finish hardware with suitable stainless steel fasteners for complete installation.

b. Products complete and of equal quality and finish.

2. Butt Hinges: ANSI A156.1.

Type	Item	ANSI/BHMA	Stanley	McKinney
H1	Heavy Weight, ball bearing, 5 knuckle	A5111	FBB199 (32D)	T4A3386

3. Locks and Latches: ANSI A156.2 or A156.13, key new locks into existing key system; furnish two keys for each lock and two master keys.

Type	Item	ANSI/BHMA	Schlage Planet	Sargent LB	Best 4C
L1	Entrance lock	F82	D53PD	8G05	84K7AB
L3	Latch set	F75	D10S	8U15	84K0N

4. Closers: ANSI A156.4 with painted finish.

Type	Item	ANSI/BHMA	LCN	Sargent
C4	Parallel arm with integral stop	C02021	4110 Cush-N-Stop Series	350-PS Series
C6	Parallel arm with integral stop and hold-open	C02061	4110-H Cush-N-Stop Series	350-PSH Series

5. Thresholds:

Type	Item	ANSI/BHMA	Pemco	Reese
T1	Saddle	--	175A	S104A

6. Weather-stripping:

Type	Item	ANSI/BHMA	Pemco	Reese
W1	Head and jamb Door shoe Rain drip	--	S88D 222AV 346C	797B DB596AF R201C

7. Finishes: ANSI A156.18, satin chromium-plated No. 626, unless indicated otherwise.

8. Nameplates: Beveled edge plastic plate, 1/8-in. thick, 2-in. high black, with 1-in. high white Helvetica letters.

C. Overhead Coiling (Roll-Up) Doors: Furnish formed interlocking curtain of galvanized steel slats with manufacturer's standard insulation and polyvinylidene fluoride finish: Kynar 500, two coats minimum in color shown or selected by CONTRACTOR.

1. Design to resist specified wind loads.
2. Curtain: Coiled on pipe of sufficient size to carry door load.
3. Counterbalance with helical springs contained in pipe.
4. House coil in sheet metal hood with internal weather-stripping.
5. Construct door with suitable opening and closing action, steel track, and ball bearing rollers.
6. Furnish accessories and fasteners required for a complete installation to include inside locking device.
7. Operation: Manually operated with endless chain.

D. Fixed Louvers:

1. General: Drainable blade type louver with self closing damper.
2. Material: 20-gauge galvanized steel; factory finish to match wall panels.
3. Free Airflow: Minimum 5 percent.

4. Weather Projection: 60 percent or more.
 5. Insect Screen: Manufacturer's standard 14 to 18 mesh.
 6. See Louver Schedule on Drawings for tabulation of louver characteristics.
- E. Metal Building Blanket Insulation:
1. ASTM C991, Type II, thickness as required to achieve a minimum R-value of 19 at exterior walls and 30 at roof.+
 2. 2-mil thick white vinyl vapor barrier backing with Water Vapor Permeance Rating of 0.1 maximum, ASTM E96, Procedure A.
 3. Flame Spread: ASTM E84, 25 or less (DOE-STD-1066-99, Section 9.3.1).
 4. Smoked Developed: ASTM E84, 50 or less (DOE-STD-1066-99, Section 9.3.1).
 5. Provide at roof and walls in R-value specified and as indicated on Drawings.
- F. Thermal Blocks: High-density, 3/4-in. thick extruded polystyrene, for installation over structural framing members.
- G. Trim: Factory-formed and factory-painted ridge cap, rake trim, simple eave trim, panel side trim, corner trim, door trim, and all other trim as necessary.
- H. Gutter Fascia and Downspouts:
1. Material: ASTM A653/A653M 26-gauge galvanized steel.
 2. Gutter Fascia:
 - a. Prefinish.
 - b. Furnish hangers with factory-applied paint.
 3. Preformed Corner Closures: Furnish to match configuration of gable fascia.
 4. Downspouts:
 - a. Configuration: Nominal 4-in. corrugated rectangular box with minimum 11 square in. of cross-section area.
 - b. Factory finish to match wall panels.
- I. Sealants and Caulking
1. Sealants and caulking shall conform to the following:
 - a. Sealant Type 4: Multipart polyurethane; ASTM C920, Type M, Grade NS, Class 25; Sonolastic NP-II, Pecora Dynatrol II, or Tremco Dymeric.

- b. Sealant Type 6: One-part polyurethane; ASTM C920, Type S, Grade NS, Class 25; Sonolastic NP-I, Pecora Dynatrol I, or Tremco Dymonic.
 - c. Sealant Type 9: One-part acrylic; Tremco Mono, Pecora 60+ Unicrylic, or PTI 738.
- J. Sealant materials shall be delivered to the job in the manufacturer's original unopened containers. The container label or accompanying data sheet shall include the following information as applicable: manufacturer, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, shelf life, and curing time at the standard conditions for laboratory tests. Materials shall be handled and stored to prevent inclusion of foreign materials. Materials shall be stored at temperatures between 4 and 27 degrees C (40 and 80 degrees F) unless otherwise specified by the manufacturer. Manufacturer shall also include material safety data sheets (MSDS) for each type of sealant used on site.
- K. Plywood
- 1. Plywood Grades: U.S. Product Standard PS 1. Identify each plywood panel with appropriate grade trademark of APA-The Engineered Wood Association.

Provide fire-retardant treated plywood panels with grade designation, APA C-C PLUGGED EXT, 3/4 in. thick, sanded surface.
 - 2. Pressure treat plywood with fire-retardant chemicals in accordance with AWWA Recommended Practice C20 and C27, respectively, so that it has a flame spread rating not higher than 25 with no evidence of significant progressive combustion when tested for 30 minutes duration under the standard Test Method UL 723, NFPA 255, and ASTM E84 and smoke developed 50 or less. Treated lumber and plywood labeled and tested by Underwriters' Laboratories, Inc. showing the performance rating.
 - 3. Fasteners (Lag, Toggle, and Miscellaneous Bolts and Screws) shall conform to ASTM A307. Type, size, and finish best suited for intended use. Screws shall be self-tapping type to connect to structural steel members. Finish options include zinc compounds, cadmium, and aluminum paint impregnated finishes.
- L. Miscellaneous: Furnish fasteners, metal-backed neoprene washers, weather stripping, sealants, roof jacks, roof curbs, gaskets, and other items as required for a complete installation.

2.4 FABRICATION

- A. **Factory Fabricate:** To manufacturer's written standards, MBMA Low Rise Building Systems Manual, and AISC LRFD Specification for Structural Steel Buildings.
- B. **Building Parts:** Accurate and true to dimension to facilitate building erection without cutting, fitting, or other alterations.
- C. **Welded Connections:** In accordance with AWS D1.1 and Technical Specification 0600X-SP-C0073 Metals.
- D. **Shop Primer for Primary Framing:**
 - 1. Clean and apply one coat of manufacturer's standard primer in accordance with MBMA Low Rise Building Systems Manual.

3.0 EXECUTION

3.1 EXAMINATION

- A. Examine supporting concrete foundation and anchor bolt placement for compliance with requirements for installation tolerances and other conditions affecting performance of metal building.

3.2 BUILDING ERECTION

- A. Erect building system in accordance with manufacturer's standards and instructions.
- B. Provide temporary bracing in accordance with MBMA standards and as required for safe installation. The metal building supplier shall incorporate permanent fall protection tie-off points to top of crest pad building roof framing as part of building design.
- C. **Structural Framing:**
 - 1. Do not field cut or alter primary or secondary framing members.
 - 2. Installation and tolerances shall be in accordance with MBMA Low Rise Building Systems Manual.
- D. **Roof and Wall Panels:**
 - 1. Field cutting of panels by torch is not permitted.

2. Attach panels to structural supports to maintain a weather tight seal while allowing for thermal and structural movement.
 - a. Install exposed fasteners in true vertical and horizontal alignment.
 - b. Field seam side laps of standing seam roof panels using electrically operated seaming machine.
 - c. Use proper tools to install screw fasteners to compress neoprene washer without damaging washer or stripping metal.
3. Install manufacturer's standard joint sealants, gaskets, and closure strips as required for weather tight installation. Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Joints shall be sealed as detailed in the drawings. Sealant shall be forced into joints with sufficient pressure to expel air and fill the groove solidly. Sealant shall be installed to the indicated depth without displacing the backing. Unless otherwise indicated, specified, or recommended by the manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags. Sealer shall be applied over the sealant when and as specified by the sealant manufacturer.
4. Field Cutting and Patching: Perform in manner not to impair appearance, weather tightness, or structural capacity of panel system.

3.3 INSTALLATION OF SEALANTS AND CAULKING

- A. Conform to ASTM C962.
- B. Backup Rod: Install in joints wider than 3/16 in.
- C. Seal joints around doors, and louver frames, and as indicated.
- D. Apply materials in accordance with manufacturer's recommendations and instructions.
- E. Fill joints completely from back to face, without voids.
- F. Tool joints concave.
- G. Clean smears and other soiling caused by sealant.

H. Replace or repair to OWNER's satisfaction damaged surfaces resulting from sealing or cleaning.

I. Application Schedule:

1. Type 4 or 6: Exterior joints.

a. Type 9: Interior joints.

3.4 INSTALLATION OF PLYWOOD

A. Plywood shall be applied with tight edges at side and end joints, and screwed at supported edges at 300 mm (12 in.) on center and at intermediate supports 300 mm (12 in.) on center.

B. Fasteners of edges shall be 13 mm (1/2 in.) from the edges. Furnish where shown on Drawings.

3.5 HARDWARE INSTALLATION AND PROTECTION

A. Mounting Dimensions: Follow National Builder's Hardware Association Standard; lock and latch backset, 2-3/4 in.

B. Follow manufacturer's instructions. Make Work neat and secure, developing full strength of components and providing intended function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during installation.

D. Set stops over solid backing after painting is complete.

E. Cope ends of thresholds neatly to jamb profile and set in sealant, anchoring securely.

F. Do fitting, dismantling, and reinstalling of finish hardware required before and after painting.

G. After installation, adjust hardware for noise-free operation without resistance.

H. Protect doors, frames, and hardware from damage after installation.

3.6 HARDWARE SETS

- A. Hardware sets are guide to functional requirements of each opening. Provide hardware complete. Size omitted shall be as recommended by manufacturer.

Item	Type
HDW-1. Single Locked Entrance Door	
1-1/2 Pair butts, 4-1/2 by 4-1/2	H1
1 Lock	L1
1 Closer	C6
1 Threshold	T1
1 Set weather-strip	W1
HDW-2. Connecting Interior Door, No Lock	
1-1/2 Pair butts, 4-1/2 by 4-1/2	H1
1 Latch	L3
1 Closer	C4
HDW-3. Overhead Coiling Door	
Slide Bolt (provided by Door Manufacturer)	N/A

- B. See Door and Hardware Schedule on Drawings for indication of hardware sets, and door and frame types.

3.7 REPAIR, CLEANING, AND PAINTING

- A. Immediately following erection, remove unused material, screws, fasteners, and other debris from completed installation. Use caution in removing metal cuttings from surface of pre-finished metal panels.
- B. Replace damaged, dented, buckled, or discolored metal panels.
- C. Repair damaged painted and galvanized surfaces as specified in Technical Specification for Finishes.
- D. Finish Painting: As specified in Technical Specification for Finishes.

3.8 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates conditions are outside the acceptable limits of

the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall maintain records of his quality control for operations including but not limited to the following:

- (1) Inspection of material delivered to the project site against approved material data list(s).
- (2) Storage and handling of materials.
- (3) Installation as required.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the CONTRACTOR within 1 working day of the inspection or test.

3.9 MANUFACTURER'S SERVICES

Provide manufacturer's representative at site for installation assistance, inspection, and certification of proper installation.

SITE WORK

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SITE WORK

1.0 GENERAL

1.1 SUMMARY

This specification establishes quality and workmanship requirements for Site Work.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meaning:

AWS	American Welding Society
ASTM	American Society for Testing and Materials
CFR	U.S. Code of Federal Regulations
FS	Federal Specifications
OSHA	Occupational Safety and Health Administration
CQC	Construction Quality Control
QAP	Quality Assurance Program
SSRS	Subcontractor/Supplier Submittal Requirement Summary
WSDOT	Washington State Department of Transportation

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Site Work. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Site Work. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C 117	Standard Test Methods for Materials Finer than 200 (75 micrometer) Sieve in Mineral Aggregates by Washing
ASTM C 131	Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	Standard Practice for Sampling Aggregates

ASTM D 422	Standard Test Method for Particle Size Analysis of Soils
ASTM D 1140	Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	Standard Test method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	Standard Test Methods for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil, and Rock by Mass
ASTM D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM F 1043	Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework
ASTM F 883	Standard Performance Specification for Padlocks
AWS WZC	Welding Zinc-Coated Steels
29 CFR 1926	Safety and Health Regulations for Construction

FS RR-F-191/GEN	Fencing, Wire and Post, Metal (Chain-Link Fence Fabric, and Accessories)
FS RR-F-191/1E	Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)
FS RR-F-191/2	Fencing, Wire and Post, Metal (Chain-Link Fence Gates)
FS RR-F-191/3E	Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)
FS RR-F-191/4	Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)
WAC 173 216	State Waste Discharge Permit Program
WAC 173 400	General Regulations for Air Pollution Sources
WSDOT M41-10	Standard Specifications for Road, Bridge, and Municipal Construction

1.4 DEFINITIONS

1.4.1 Clearing

Clearing shall consist of shredding vegetation within the limits of construction. It shall also include the satisfactory disposal of the cleared material and other rubbish from areas that are to be grubbed.

1.4.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm (3 in.) in diameter, and matted roots from the designated areas.

1.4.3 Satisfactory Materials

Materials classified in ASTM D 2487 as GW, GP, GM, GW-GM, SW, SP, SM, SP-SM and SW-SM and free from roots and other organic matter, trash, debris, and frozen materials.

1.4.4 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials and materials classified in ASTM D 2487 as Pt, OH, and OL are unsatisfactory. Unsatisfactory materials also include man-made fills, refuse, or backfills from previous construction.

1.4.5 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP.

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Testing required for classifying materials shall be in accordance with ASTM D 4318 (for admix and excavation fill soils containing >12% fines passing the #200 sieve), ASTM C 136, ASTM D 422, and ASTM D 1140.

1.4.6 Degree of Compaction

Degree of compaction is a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated hereinafter as a percent of maximum density.

1.4.7 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 75 mm (3 in.) in any dimension or as defined by the pipe manufacturer, whichever is smaller.

1.4.8 Unstable Material

Unstable material shall consist of materials too wet or too soft to properly support the materials to be placed on or above it.

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.5.1 Manufacturer's Literature

Manufacturer's descriptive data, catalog cuts, literature and other data as necessary to fully describe that materials comply with specified requirements.

1.5.2 Field Testing Control

Qualifications of the commercial testing laboratory, procedures, personnel, etc. performing testing in accordance with paragraph FIELD TESTING CONTROL and Construction Quality Requirements, Specification No. 0600X-SP-G0037.

1.5.3 Materials Test Reports

Certified test reports and analysis certifying materials conform to the specified requirements, and for tests conducted in accordance with paragraph FIELD TESTING CONTROL and Construction Quality Requirements, Specification No. 0600X-SP-G0037. Provide copies of laboratory and field test reports within 1 working day of the completion of the test.

1.6 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings. The subsoil investigation report is included as an attachment to the specifications. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.7 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and excavation will be designated as unclassified excavation.

2.0 MATERIALS AND EQUIPMENT

2.1 SELECT BORROW MATERIAL

Borrow material shall be selected from material excavated under this Subcontract and shall meet the requirements and conditions of the particular fill for which it is to be used.

2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility. Tape shall be a minimum of 75 mm (3 in.) in width.

Red:	Electric
Blue:	Water Systems
Purple:	Leachate (use "Reclaimed Water" inscription)
Yellow:	Transfer Line

2.3 EROSION CONTROL MATERIALS

2.3.1 Fertilizer

Fertilizer to be applied shall be a commercial, chemical type, uniform in composition, free flowing, conforming to State and Federal laws suitable for application with a grain seed drill.

Fertilizer shall have a guaranteed analysis showing not less than 16 percent nitrogen, 16 percent available phosphate, and 16 percent water-soluble potash.

2.3.2 Seed

Seed shall be delivered to job site in original unopened packages bearing content tags. Seed shall be guaranteed 95 percent pure live seed with a minimum germination rate of 85 percent. Seed shall be crested wheatgrass, variety Hycrest (*Agropyron cristatum x desertorum*), Sherman's Big Bluegrass (*Poa ampla*), and Bluebunch Wheatgrass variety Secar (*Agropyron spicatum*).

2.3.3 Mulch

Straw mulch shall be applied after drill or broadcast seeding. Mulch shall be grass straw, free from noxious weeds. The straw shall be capable of being applied over the seedbed using a mulcher or straw spreader pulled by a tractor.

2.3.4 Hydromulch

Hydromulch shall be a wood fiber based mulch.

2.4 CHAIN LINK FENCE

2.4.1 Fabric

FS RR-F-191/1, Type I, zinc-coated steel wire with minimum coating weight of 370 grams (1.2 ounces) of zinc per square meter (square ft) of coated surface, or Type II, aluminum-coated steel wire. Fabric shall be fabricated of 11-gauge wire woven in 51 mm (2-in.) mesh. Fabric height shall be 1.83 m (6 ft) for perimeter fence, and 2.44 m (8 ft) for collection fence. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

2.4.2 Posts

FS RR-F-191/3, zinc-coated; Class 1 Grade A or B, steel pipe; Class 3, formed steel sections; Class 6, steel square sections; or DQ-40 galvanized steel pipe meeting ASTM F699. Class 4, steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same class throughout the fence. Gatepost shall be either round or square, subject to the limitation specified in FS RR-F-191/3.

2.4.3 Braces

FS RR-F-191/3, zinc-coated, Class 1, Grade A or B, steel pipe, size SP1. Class 3, formed steel sections, size FS1, conforming to FS RR-F-191/3, may be used as braces if Class 3 line posts are furnished.

2.4.4 Accessories

FS RR-F-191/4. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Tie wire for attaching fabric to rails, braces, and posts shall be 9-gauge steel wire.

2.4.5 Concrete

ASTM C 94, using 19 mm (3/4-in.) maximum size aggregate, and having minimum compressive strength of 18 MPa (2500 psi) at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

2.5 SELECT GRANULAR MATERIAL

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a 0.075 mm (No. 200) mesh sieve and no less than 95 percent by weight passing the 25-mm (1-in.) sieve.

2.6 BEDDING AND INITIAL FILL MATERIAL

Bedding and initial backfill for utilities shall consist of select granular material. The maximum allowable aggregate size shall be not more than 25 mm per 300 mm (1 in. per ft) of pipe diameter, 75 mm (3 in.) maximum, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.7 TYPE I FILL

Type I fill shall consist of satisfactory materials with a maximum particle size of 150-mm (6 in.).

2.8 TYPE II FILL

Type II fill shall consist of satisfactory materials with a maximum particle size of 25-mm (1-in.).

2.9 BASE MATERIAL, CRUSHED SURFACING BASE COURSE (CSBC)

Base material and crushed surfacing base course (CSBC) shall be 32-mm (1.25 in.) minus crushed base course in accordance with the requirements of WSDOT 9-03.9(3).

2.10 SURFACE MATERIAL, CRUSHED SURFACING TOP COURSE (CSTC)

Surface material and crushed surfacing top course (CSTC) shall be 19 mm (0.75 in.) crushed Top Course and Keystone in accordance with the requirements of WSDOT 9-03.9(3).

3.0 EXECUTION

3.1 GENERAL

Areas within the limits of construction shall be cleared and grubbed unless otherwise noted. The SUBCONTRACTOR shall survey and locate the limits of clearing and grubbing prior to initiating clearing and grubbing activities. Areas within the Cells 7 & 8 Stockpile Area shown on Drawing No. 0600X-DD-C0297 do not have to be grubbed prior to placement of stockpiled soil, unless base soil is excavated from the stockpile area.

Excavations shall be performed in accordance with the requirements of 29 CFR 1926, Subpart P, Exhibit "G," Subcontractor Safety and Health Requirements and Exhibit "E," Technical Specifications. The Subcontractor's OSHA competent person for excavations shall maintain daily records of excavation observations and be responsible for implementing corrective actions for potentially unsafe conditions based upon physical observations noted and other conditions in the field. SUBCONTRACTOR shall submit the names and qualifications of OSHA competent persons for excavations. No excavation work shall take place if a competent person is not onsite.

The SUBCONTRACTOR shall protect existing structures and embankments. Any structure or buried utilities damaged during clearing and grubbing operations shall be reported to the CONTRACTOR and shall be replaced or repaired by the SUBCONTRACTOR at no additional cost to the CONTRACTOR.

Entry and exit points into excavations shall be marked and maintained. Ramps utilized for entry shall be maintained free of slip and trip hazards.

Equipment operating near excavations shall be operated at a distance from the banks of the excavation to support the weight of the equipment, but in no instance closer than 600 mm (2 ft). SUBCONTRACTOR shall prevent cave-ins, equipment turn over, etc.

3.2 CLEARING AND GRUBBING

Vegetation shall be cleared by using a "brush-hog", or similar equipment, to cut, chip, and size reduce the organic material to chips and slash that will be removed from excavation area surface. Vegetation shall be cut down to within 150 mm (6 in.) of the ground surface. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. This includes, but is not limited to, loose rocks, boulders, and rock piles. Loose rocks, boulders, and rock piles shall be removed and disposed of in a location designated by the CONTRACTOR. Cleared and grubbed material shall be removed and disposed of in the unsatisfactory materials stockpile.

In areas to be grubbed, material shall be removed to a depth of not less than .03 meters (12 in.) below the original ground surface. Cleared material and other rubbish shall be removed and the remaining soil shall be stockpiled according to the soil's classification as described in "Definitions" of the specification.

3.3 EXCAVATION

3.3.1 General

Excavation of every description, regardless of material encountered shall be performed to the lines, grades, and elevations shown on the drawings and specified herein. Material required for fills shall be obtained from cell excavation or stockpiles if approved by CONTRACTOR. Satisfactory excavation material shall be transported to and placed in fill areas such as embankment, subgrades, shoulders, and other similar fills within the limits of the work or disposed of in the stockpile area shown on the drawings. Excavation below indicated depths shall not be permitted except to remove unsatisfactory material. In the event that unsatisfactory material is encountered below the grades shown or specified, the CONTRACTOR shall be notified. Determination of elevations and measurements of approved over depth excavation of unsatisfactory material and the replacement of such material with satisfactory material shall be done under the direction of the CONTRACTOR.

Excavations below the depths indicated, without specific directions, shall, except as otherwise specified, be refilled and compacted in accordance with Section 3.11 of 0600X-SP-C0072 to the proper grade with the appropriate type of material at no additional cost to the CONTRACTOR. Excavation and filling shall be performed in a manner and sequence that will provide drainage. Excavations shall be kept free from water while construction therein is in progress. Surface water shall be directed away from excavation and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes, pumping, and grading shall be provided and maintained by the SUBCONTRACTOR as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Vertical excavation slopes shall not be left overnight, weekends, or holidays. CONTRACTOR approval is required to barricade vertical slopes in lieu of dressing.

SUBCONTRACTOR may construct additional access ramps to facilitate excavation of the cell. SUBCONTRACTOR's access ramps located on the north and south side slopes shall be removed to the lines and grades shown on the Drawings in Exhibit "F". CONTRACTOR may elect to keep SUBCONTRACTOR's access ramp(s) located on the east side slope. SUBCONTRACTOR's access ramps located on the east side slope shall be removed as directed by the CONTRACTOR. The access ramp located on the east slope shown on the Drawings in Exhibit "F" shall be constructed to the lines and grades shown on the Drawings.

3.3.2 Buildings

Excavation for buildings shall include trenching for utility systems to a point 1.5 m (5 ft) beyond the building line of each building and structure. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. Where excavations for footings are carried below the depths indicated without prior approval, the concrete footings shall be increased in thickness to the bottom of the over depth excavations and additional reinforcement included therein as determined necessary by the CONTRACTOR at the SUBCONTRACTORS expense.

3.3.3 Utilities Systems

During excavation, material satisfactory for backfilling utility systems shall be stockpiled in an orderly manner in accordance with OSHA 29 CFR 1926 trenching and shoring requirement at a distance from the banks of the trench equal to 1/2 the depth of the excavation, but in no instance closer than 600 mm (2 ft).

3.3.3.1 Utility Trench Excavation. The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be vertical and at a width recommended in the manufacturers installation manual. Trench walls more than 1.2 meters (4 ft) high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Trench walls which are cut back shall be excavated to meet the requirements of 29 CFR 1926. Special attention shall be given to slopes that may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 600 mm (24 in.) plus pipe outside diameter (O.D.) for pipes of less than 600 mm (24 in.) inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the SUBCONTRACTOR. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the SUBCONTRACTOR without any additional cost to the CONTRACTOR.

3.3.3.2 Removal of Unyielding Material. Where unyielding material is encountered in the bottom of the trench, such material shall be removed a minimum 100mm (4 in.) below the required grade and replaced with bedding and initial backfill material as provided in paragraph BACKFILLING AND COMPACTION OF UTILITIES SYSTEMS.

3.3.3.3 Removal of Unstable Material. Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed by the CONTRACTOR and replaced to the proper grade with bedding and initial backfill material as provided in paragraph BACKFILLING AND COMPACTION OF UTILITIES SYSTEMS. When removal of unstable material is required due to the fault or neglect of the SUBCONTRACTOR, the resulting material shall be excavated and replaced by the SUBCONTRACTOR without additional cost to the CONTRACTOR.

3.3.3.4 Excavation for Appurtenances. Excavation for precast manholes or similar structures shall be sufficient to leave at least 300 mm (12 in.) clear between the outer structure surfaces and the face of the excavation or support members.

3.4 PREPARATION OF GROUND SURFACE FOR FILLS AND EMBANKMENTS

3.4.1 Structural Fills and Waste Trench Embankments

Ground surface on which structural fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material to a depth of 300 mm (12 in.). Ground surface shall be plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to not less than 95 percent of maximum density as determined by ASTM D1557. The prepared ground surface shall be scarified and moistened or aerated as required just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

3.4.2 General Fill Areas and Excavation Soil Stockpile Area

Ground surface on which general fill and excavation soil stockpile is to be placed shall be cleared.

3.5 SUBGRADE PREPARATION FOR BUILDINGS

The surface shall be scarified to a depth of 150 mm (6 in.) and shall be compacted to not less than 95 percent of maximum dry density as determined by ASTM D1557 prior to placing fill or backfill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Approved compacted subgrades that are disturbed by the SUBCONTRACTOR's operations or adverse weather shall be scarified and recompacted as specified to the required density prior to further construction. Recomposition over underground utilities shall be by hand tamping, except for concrete encased duct banks.

3.6 UTILITY TRENCH BOTTOM PREPARATION

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe or conduit. The pipe trench bottom shall be given a final trim, using a string line or laser for establishing grade, such that each pipe section when first laid will be continually in contact with the ground along the extreme bottom of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing.

3.7 SUBGRADE PREPARATION FOR ROADWAYS

3.7.1 Construction

Subgrade shall be Type I material which is shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with Type I material or other approved material as directed. Low areas resulting from removal of unsatisfactory material shall be brought up to required grade with Type I materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. The elevation of the finished subgrade shall not vary more than 30 mm (0.1 ft) from the established grade and cross section.

3.7.2 Compaction

Subgrade shall be moisture conditioned and compacted to at least 90 percent maximum density as determined by ASTM D1557 for a depth of 305 mm (12 in.).

3.8 FILLING AND BACKFILLING FOR BUILDINGS

Type I fill shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Type I fill shall be placed in horizontal layers not exceeding 200 mm (8 in.) in loose thickness, or 150 mm (6 in.) when hand-operated compactors are used. After placing, each layer shall be plowed, disked or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved by CONTRACTOR, underground utilities systems have been inspected, tested and approved by CONTRACTOR, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Backfill shall not be placed in wet or frozen areas. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation than a distance equal to the height of backfill above the top of footing. The area remaining shall be compacted in layers not more than 100 mm (4 in.) in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Each layer of fill and backfill shall be compacted to not less than 95 percent of maximum dry density as determined by ASTM D1557.

3.9 BACKFILLING AND COMPACTION OF UTILITIES SYSTEMS

Backfill material shall consist of bedding and initial backfill material or Type I fill as required by the Drawings and these specifications. Backfill shall be placed in layers not exceeding 150 mm (6 in.) loose thickness for compaction by hand operated machine compactors, and 200 mm (8 in.) loose thickness for other than hand operated machines. Each layer shall be compacted to at least 90 percent maximum dry density, unless otherwise specified for backfill of roadways and buildings.

3.9.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 600 mm millimeters (2 ft) above the top of pipe prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test.

3.9.1.1 Replacement of Unyielding Material. Unyielding material removed from the bottom of the trench shall be replaced with bedding and initial backfill material.

3.9.1.2 Replacement of Unstable Material. Unstable material removed from the bottom of the trench or excavation shall be replaced with bedding and initial backfill material placed in layers not exceeding 150 mm (6 in.) loose thickness.

3.9.1.3 Bedding and Initial Backfill. Bedding and initial backfill material shall be placed and compacted with tampers to a height of at least one foot above the top of utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

Bedding and initial material shall be provided for sewers, drainage pipelines, and other gravity flow pipelines.

After compacting the bedding, the SUBCONTRACTOR shall perform a final trim using a string line (or laser) for establishing grade, such that the extreme bottom of each pipe section is continually in contact with the bedding. Excavation for pipe bells and welding shall be made as required.

3.9.1.4 Final Backfill. The remainder of the trench, except for special materials for roadways, shall be filled with Type I fill. Backfill material shall be placed and compacted as required for the general area surrounding the utility trench.

3.10 BACKFILL FOR ROADWAYS

Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs SUBGRADE PREPARATION FOR ROADWAYS. Additionally, the material shall be placed in successive horizontal layers of 200 mm (8 in.) in loose depth for the full width of the cross section.

3.11 FILLS AND EMBANKMENTS

3.11.1 Structural Fills and Waste Trench Embankments

Fills and embankments shall be constructed at the locations and lines and grades indicated. The completed fill shall conform to the shape of the typical sections indicated or shall meet the

requirements of the particular case. Type I fill shall be used unless otherwise specified. No frozen material shall be permitted in the fill. Stones having a dimension greater than 100 mm (4 in.) shall not be permitted in the upper 150 mm (6 in.) of fills or embankments. The material shall be placed in successive horizontal layers of 200 mm (8 in.) in loose depth for the full width of the cross section and shall be compacted to at least 95 percent maximum dry density. Each layer shall be compacted and tested before the overlaying lift is placed. Moisture content of the fill or backfill material shall be adjusted by wetting or aerating to provide the moisture content required to obtain 95 percent of maximum dry density as determined by ASTM D1557.

3.11.2 General Fills

General Fill areas are limited to the areas identified on the drawings. Type I fill shall be used to bring the general fill areas to the lines and grades indicated. The material shall be placed in lifts not to exceed 200 mm (8 in.) in loose depth and shall be compacted to 90 percent of maximum dry density.

3.11.3 Fill for Anchor Trenches

Fill material for Anchor Trenches shall consist of Type II fill material. Fill shall be placed in lifts not to exceed 150 mm (6 in.) in loose depth and compacted by a hand held mechanical or rubber tired compaction equipment, or other as approved by CONTRACTOR. Finished backfill shall be adequately sloped and drained to prevent ponding of water or softening of fill and adjacent soils.

3.11.4 Fill for Termination Berms

Type I fill shall be used for the Termination Berms and the Termination Protective Soils. Fill shall be placed in lifts not to exceed 0.9 m (36 in.) in compacted depth and tracked with grading equipment. The fill shall be sufficiently wetted to eliminate soft pockets of dry material, and the surface compacted to 90 percent of the maximum dry density as determined by ASTM D 1557.

3.11.5 Fill for Riser Pipes

Type II fill shall be used for the fill around the sump riser pipes, sump level transducer pipes, and lysimeter access pipe. Fill shall be placed in lifts not to exceed 200 mm (8 in.) in loose depth and compacted to 90 percent of the maximum dry density as determined by ASTM D 1557. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Care shall also be taken that the underlying pipes and geosynthetics are protected in accordance with the paragraph titled MATERIALS IN CONTACT WITH GEOMEMBRANES OR GEOCOMPOSITES in Specification No. 0600X-SP-C0069.

3.12 FINISHING FOR ROADWAYS

Roadway and shoulder surfaces shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish shall be within 30 mm (0.1 ft) of the grades and elevations indicated on design drawings.

3.13 FINISHED EXCAVATION, FILLS, AND EMBANKMENTS OTHER THAN FOR ROADWAYS AND BUILDINGS

Areas covered by the limits of construction on the design drawings including excavated and filled sections and adjacent transition areas, shall be uniformly smooth-graded. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from blade-grader operations, but not more than 45 mm (0.15 ft) above or below the established grade and approved cross section, except as otherwise specified. Ditches and swales shall be finished to allow effective drainage and erosion control.

3.14 BASE AND SURFACE MATERIAL INSTALLATION

The surface on which the base and surface materials is placed, shall conform to the Subcontract requirements, and shall be approved by the CONTRACTOR before placement of base materials. No base or surface material shall be placed on snow, soft, muddy, or frozen subgrade.

3.14.1 Placement and Shaping

The SUBCONTRACTOR shall provide a homogeneous mixture of unsegregated and uniformly dispersed materials in position for compacting in layers not to exceed 200 mm (8 in.) of compacted material. During placement and compaction, the moisture content of the material shall be maintained at the highest level practical for the material without causing free water to drain through the material and build up on lower courses or on the subgrade. The SUBCONTRACTOR shall apply frequent light applications of water rather than heavy applications of water to provide the necessary moisture.

3.14.2 Compaction

Immediately following spreading and final shaping, the full depth of each layer shall be compacted to a minimum of 95 percent of maximum dry density as established by ASTM D 1557 before the next succeeding layer is placed.

3.15 STOCKPILES

SUBCONTRACTOR shall submit for approval a stockpile plan complete with procedure for stockpiling and maintaining excavation soil material. Stockpiles shall be kept in a neat and well-drained condition, giving due consideration to drainage. The ground surface at stockpile locations shall be sealed by rubber-tired equipment. Stockpile of satisfactory materials shall be

protected from contamination that may destroy the quality and fitness of the stockpiled material. If the SUBCONTRACTOR fails to protect the stockpile, and any material becomes unsatisfactory, such material shall be removed at no additional cost to the CONTRACTOR.

SUBCONTRACTOR shall maintain a separate stockpile for Eolian base soil. Eolian base soils shall not be mixed with other soils.

3.16 DITCHES AND SWALES

Ditches and swales shall be cut accurately to the cross sections and grades indicated. Roots, stumps, rock, and foreign matter in the sides and bottom of ditches and channel changes shall be trimmed and dressed or removed to conform to the slope, grade, and shape of the section indicated. Care shall be taken not to excavate ditches below the grades indicated. Excessive ditch and swale excavation shall be backfilled to grade with Type I material, thoroughly compacted. Ditches and swales excavated under this section shall be maintained until final acceptance of the work.

3.17 SHORING

Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable requirements of 29 CFR 1926 Subpart P. Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent cave-ins.

3.18 FIELD TESTING CONTROL

Testing is the responsibility of the SUBCONTRACTOR. Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the SUBCONTRACTOR. No work requiring testing shall be performed until the facilities, procedures, construction quality control plan, etc. have been inspected and approved by the CONTRACTOR. The SUBCONTRACTOR, or subtiers shall provide copies of nuclear gauge licenses, calibrations, procedures, and training certificates for operators.

When ASTM D 2922 is used for field in-place density testing, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the CONTRACTOR.

Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the CONTRACTOR. When test results indicate, as determined by the

CONTRACTOR, that compaction is not as specified, the material shall be removed, replaced and recompact to meet specification requirements, at no additional expense to the CONTRACTOR. Tests on recompact areas shall be performed to determine conformance with specification requirements. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests.

Testing requirements can be found in Specification G0037, Section 2.11-MINIMUM TESTING REQUIREMENTS. If there are discrepancies between C0072 and G0037, the more stringent requirements will be followed.

3.19 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the SUBCONTRACTOR in a satisfactory condition until pavement is placed. The storage or stockpiling of materials on the finished subgrade shall not be permitted. Areas within 1.5 m (5 ft) outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.19.1 Tolerance Tests for Roadways

Continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION FOR ROADWAYS shall be made during construction of the subgrades and as specified in FINISHING FOR ROADWAYS for placement of base materials on roadway surface.

3.20 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.20.1 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 600 mm (24 in.) from the finished grade, unless otherwise indicated.

3.20.2 Plastic Marking Tape

Warning tapes shall be installed directly above the buried utility (pipe, conduit, direct buried cable, etc.), at a depth of 457 mm (18 in.) below finished grade unless otherwise shown.

3.20.3 Road Closures

Trench excavations crossing roads, or any other construction activity which may impede vehicle traffic flow, shall be limited to the hours of 8:00 am to 3:00 pm, and 6:00 pm to 6:00 am, Monday through Friday. There are no time restrictions on weekends. The SUBCONTRACTOR shall maintain one lane of traffic open or provide alternate temporary roadways during construction activities on or near roadways. Trenches that cross existing roads shall be backfilled prior to rush hour traffic ingress or egress. Cuts through paved roads shall be asphalted within 48 hours of backfilling.

3.21 VEGETATIVE EROSION CONTROL

The SUBCONTRACTOR shall provide erosion protection including fertilizing, seeding, and mulching for areas that are disturbed including slopes equal to or greater than 4H:1V and in the bottom of drainage ditches and swales and the material in the stockpile area. Application of vegetative erosion control for the stockpile area shall be either by drill or Broadcast seed method on surfaces permitting safe tractor operation. Surfaces too steep for safe tractor operation shall be hydrosseeded. No vegetative control is required on the interior sloping walls or bottoms of Cells.

SUBCONTRACTOR shall coordinate transportation and use of fertilizer with CONTRACTOR.

SUBCONTRACTOR will not be allowed to store fertilizer on-site overnight. Additionally SUBCONTRACTOR shall coordinate with CONTRACTOR for additional required on-site Hanford Security Procedures.

3.21.1 Soil Preparation

The soil to be seeded shall be graded in conformance with the Drawings and shall be loose and reasonably free of large rocks and other material(s) that may interfere with successful seeding.

3.21.2 Method of Application

Fertilizer and seed shall be applied using a range or grain drill or broadcast seeder. Straw shall be applied by a mulcher designed to apply this material on surfaces safe for tractor operation.

3.21.3 Fertilizer Rate

Fertilizer application shall be 135 kg/ha (approximately 120 lb/acre).

3.21.4 Seed Rate

The seed and seeding rate are as follows: Crested Wheatgrass Hycrest variety (*Agropyron desertorum*) 11.3 kg/ha (10 lb/acre), Sherman's Big Bluegrass (*Poa ampla*) 5.6 kg/ha (5

lb/acre), and Bluebunch Wheatgrass variety Secar (*Agropyron spicatum*) 5.6 kg/ha (5 lb/acre) of seed.

3.21.5 Mulch Rate

Straw mulch shall be applied at rate to cover the soil surface 5 to 10 cm deep (2 to 4 in) or use of a standard up to 5600 kg/ha (approximately 4000 lb/acre), upon the completion of drill or broadcast seeding. Straw mulch shall be crimped into place to prevent wind erosion.

Wood fiber mulch shall be applied at 2250 kg/ha (2000 lb/acre) after the seed and fertilizer. The wood fiber mulch and polyacrylamide soil stabilizer shall be distributed with a hydroseeder on steep soil surfaces after the seed and fertilizer have been applied.

3.21.6 Seed Drill Method

The seed application consists of using a grain or range drill to apply both seed and fertilizer concurrently. The seed drill shall be pulled using a 4-wd tractor to ensure even seeding on steeper slopes. The seed shall be placed between 0.64 to 1.27 cm (0.25 to 0.50 in) deep in the soil by the seed drill at rates specified in Sections 3.21.3 and 3.21.4.

3.21.7 Broadcast Seed Method

Broadcast seeding shall evenly distribute the seeds and fertilizer as specified in Sections 3.21.3 and 3.21.4. Upon the completion of broadcast seeding, a tractor pulled cultipacker shall be pulled over the entire seeded area.

3.21.8 Polyacrylamide Soil Stabilizer Application

A polyacrylamide soil stabilizer shall be evenly applied over the seeded areas at a rate of 37 kg/ha (15 lbs/acre) and activated with 7410 gallons of water per hectare (3000 gal/acre).

3.21.9 Time of Seeding

Seeding shall not be started until after application of all earthwork and site grading. Polyacrylamide soil stabilizer may be applied prior to seeding to minimize soil erosion upon the completion of construction activities. Seeding shall be performed in December through January or as approved by CONTRACTOR. The SUBCONTRACTOR shall return to the site after completion of the project if the project schedule does not allow for a fall planting prior to the project completion date.

3.21.10 Watering

The SUBCONTRACTOR shall provide dust control during seeding operations by water truck or irrigation to prevent visible dust. Irrigation of the seedbed after polyacrylamide application will be required to activate the soil stabilizer product. Amount of irrigation shall be determined per

manufacturer's recommendation. Additional irrigation after seeding and mulching will only be necessary to control visible dust. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired by the SUBCONTRACTOR at no additional cost to the CONTRACTOR.

3.22 CHAIN LINK FENCE

Fence shall be installed to the lines and grades indicated on design drawings. Line posts shall be spaced equidistant at intervals not exceeding 3.05 m (10 ft). Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 152.4 m (500 ft). Damage to the galvanized surface due to welding shall be repaired with "repair sticks" of zinc-cadmium alloys or zinc-tin-lead alloys per AWS WZC.

3.22.1 Post Holes.

Postholes shall be cleared of loose material. Waste material shall be spread where directed by the CONTRACTOR. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 51 mm (2-in.) clearance between the bottom of the fabric and finish grade.

3.22.2 Posts

Posts shall be set plumb and in alignment. Posts shall be set in concrete to the depth indicated on the drawings. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Fence post rigidity shall meet the following requirement. When a 222 newton (50-pound) force is applied on the post, perpendicular to the fabric, at 1.52 m (5 ft) above ground, post movement measured at the point where the force is applied shall be less than or equal to 19 mm (3/4 in.) from the relaxed position.

3.22.3 Top Rails

Top rails are not required for this project. Top tension wire shall be installed in place of top rails.

3.22.4 Braces and Truss Rods

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal.

3.22.5 Tension Wires

Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 102 mm (4 in.) of the installed fabric. Bottom tension wire shall be installed within the bottom 152 mm (6 in.) of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

3.22.6 Chain Link Fabric

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 381 mm (15-in.) intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 381 mm (15-in.) intervals and fastened to tension wires at approximately 610 mm (24-in.) intervals. Fabric shall be cut by untwisting and removing pickets.

Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 51 mm (2 in.) (plus or minus 13 mm [1/2 in.]) above the ground. Chain link fabric shall meet the following requirement. After being exercised by applying a 222 newton (50-pound), push-pull force at the center of the fabric between the posts, the use of a 133 newton (30-pound) pull at the center of the panel shall cause fabric deflection of not more than 64 mm (2.5 in.) when pulling fabric from the post side of the fence.

3.23 SIGNAGE

Signage shall meet all requirements for layout and color as specified by DOE. Requirements can be obtained from CONTRACTOR. Typeface on all signage shall be Helvetica.

3.23.1 Post Holes

Posts holes shall not be less than the diameter shown on the drawings. Waste material shall be spread where directed by the Contractor. Prior to placement of posts, holes should be inspected to ensure it is clear of loose material and rubbish.

3.23.2 Posts

Posts shall be set plumb and in alignment. Posts shall be set in concrete to the depth indicated on the drawings.

3.23.3 Signs

Signs shall be fabricated and fastened according to their respective details on drawing 0600X-DD-CO263.

3.23.4 Concrete Fill

ASTM C 94, using 19 mm (3/4 in.) maximum size aggregate, and having minimum compressive strength of 18 MPA (2500 psi) at 28 days. Concrete shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome.

3.24 CONSTRUCTION QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall maintain and submit to CONTRACTOR records including but not limited to the following:

- (1) Excavation and backfill to lines and grades indicated.
- (2) Field moisture and density tests.
- (3) Methods and procedures for providing drainage away from excavations.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be supplied to the CONTRACTOR within one working day of the inspection or test.

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METALS

1.0 GENERAL

1.1 SUMMARY

This specification establishes quality and workmanship requirements for the supply and installation of metal structures.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meanings:

AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
MSDS	Material Data Safety Sheet
CQC	Construction Quality Control
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
SSRS	Subcontractor Submittal Requirements Summary
CQC	Construction Quality Control
WAC	Washington Administrative Code
WPS	Welding Procedure Specification

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved by the CONTRACTOR or shown in this specification, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for fabrication, erection, installation and inspection of metal structures. Referenced test methods, specifications, and recommended practices listed below are to be used for material property verification and the identification of acceptable practices applicable to metal structures.

Failure of identifying applicable codes and standards by this specification and by CONTRACTOR does not imply elimination of required knowledge and compliance to perform work by the SUBCONTRACTOR.

AISC-325 Steel Construction Manual, 13th Edition

AISC S303 Code of Standard Practice for Steel Buildings and Bridges

AISC S329	Allowable Stress Design Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts
AISC S348	Load and Resistance Factor Design (LRFD) Specification for Structural Joints Using ASTM A325 or A490 Bolts
AISC 360	Specification for Structural Steel Buildings
ANSI/AWS Z49.1	Safety in Welding, Cutting, and Allied Processes
ASNT-01	Recommended Practice SNT-TC-1 A: Personal Qualification and Certification in Nondestructive Testing
ASTM A 6	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Steel Piling
ASTM A 36	Standard Specification for Carbon Structural Steel
ASTM A 242	Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 563	Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM C 645	Standard Specification for Nonstructural Steel Framing Members
ASTM C 754	Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM F 436	Standard Specification for Hardened Steel Washers
ASTM F 844	Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ANSI/ASME B18.21.1	Lock Washers (Inch Series)
ANSI/ASME B46.1	Surface Texture, Surface Roughness, Waviness and Lay
SSPC Paint 25	Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand-Cleaned Steel
AWS A2.4	Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0	Standard Welding Terms and Definitions

AWS D1.1	Structural Welding Code – Steel
WAC 296-24	General Safety and Health Standards
WCH-56	General Design Criteria Document for River Corridor Closure Contract
0600X-SP-C0070	Specification for Reinforced Concrete for Environmental Restoration Disposal Facility (ERDF) Cells 7, 8, 9, & 10 Construction
0600X-SP-G0037	Specification for Quality Control Requirements for Environmental Restoration Disposal Facility (ERDF) Cells 7, 8, 9, & 10 Construction
0600X-SP-G0038	Specification for Supplier Quality Assurance Program Requirements for Environmental Restoration Disposal Facility (ERDF) Cells 7, 8, 9, & 10 Construction

1.4 DEFINITIONS

Definitions of welding terms shall be in accordance with AWS A3.0

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I," Subcontractor/Supplier Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays. The following submittals shall be submitted to CONTRACTOR and approved by the CONTRACTOR prior to procurement, assembly, and installation of any metal structure. Submittals specific to this specification shall include, but not be limited to, the following:

1.5.1 Shop Drawings

- a. Shop detail drawings and erection drawings shall be submitted. Approval of the shop detail drawing codes does not relieve SUBCONTRACTOR of responsibility for compliance with design drawings, specifications, and for completeness and accuracy of all dimensions and details. Titles of shop detail drawings and erection drawings shall correspond to the specific design drawings. Each shop drawing shall include a reference to this specification number and a bill of materials showing the piece mark number, the number of members required, shape designation, detailed length, unit weight of each member, total weight for each member, and total weight of all materials detailed on the drawing. Erection drawings shall show the marking and position of each member, details of all members and their connections, foundation plans for seating anchor bolts and base plates, and bolt schedules for erection. An index of shop details and erection drawings shall be provided. As-built shop detail drawings and erection drawings shall be submitted to the CONTRACTOR after erection is complete.

- b. Welding Procedure in shop and field welding shall be in accordance with AWS D1.1 unless otherwise indicated on the design drawings, and shall be submitted. Weld connections shall be shown using AWS A2.4 welding symbols indicating net weld lengths, locations, and designated field or shop welds. NOTE: AWS D1.1 requires records be kept of welding procedure and welder qualifications.

1.5.2 Manufacturer's Mill Certificate

Certify that products meet or exceed specified requirements.

1.5.3 Mill Test Reports

Manufacturer's certificates indicating structural strength, destructive and non-destructive test analysis.

1.5.4 Welder's Qualification and Certificates

Certified welders employed on the work, verifying AWS qualification within the previous 12 months. See Section 1.8.2.

1.5.5 Weld Inspection Certificates

1.5.6 Manufacturer's Standard Painting System Data Sheet

1.5.7 Weld Procedure Specification (WPS)

1.5.8 Written Procedures

Written procedures for storage, handling, surface preparation, application, touch-up and repair, curing and inspection of coating to be submitted prior to use within 30 days after mobilization for construction.

1.5.9 Documentation

Documentation verifying inspection and non-destructive testing personnel are qualified in accordance with ASNT-SNT-TC-1A for levels I or II in the applicable non-destructive testing material.

1.5.10 Suspect/Counterfeit Warrant

Suppliers to the SUBCONTRACTOR shall warrant that "all items furnished under this Purchase Order/Contract Order are genuine (i.e., not counterfeit) and match the quality, test reports, markings and/or fitness for use required by the Subcontract." The statement shall be on supplier letterhead and signed by an authorized agent of the supplier. Any materials furnished as part of

this Subcontract, which have been previously found to be suspect/counterfeit by the Department of Energy shall not be accepted.

1.5.11 Test Reports

See Section 3.3.2.

1.5.12 Notifications

See Section 3.3.3.

1.5.13 Verification of Compliance

See Sections 3.3 and 3.9.

1.5.14 SUBCONTRACTOR CQC Plan

See Specification No. 0600X-SP-G0037.

1.5.15 SUBCONTRACTOR QAP

See Specification No. 0600X-SP-G0038.

1.5.16 MSDSs, Drawings, and Bill of Materials

See Section 3.8.4.

1.6 GENERAL REQUIREMENTS FOR FABRICATION AND INSTALLATION

1.6.1 Welding

Welding design, fabrication, installation, inspection and qualification shall conform to AWS D1.1 to meet the design criteria as specified in WCH-56, "General Design Criteria for River Corridor Closure Contract" using AISC 360 Design Guides and Practices unless otherwise specified in the Subcontract. Welding shall not be started until welding procedures, welders, welding operators, and tackers have been qualified and the submittals approved by the CONTRACTOR

1.6.2 Structural Steel

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude. The SUBCONTRACTOR shall be responsible for workmanship that conforms to AISC Code of Standard Practice for Steel Building and Bridges, AISC 303-05.

Fabrication, installation, inspection, and qualification of metal structures shall meet the design criteria specified in WCH-56, "General Design Criteria for River Corridor Closure Contract" using AISC 360 Design Guides and Practices unless otherwise specified by this document. Connections, for any part of the structure not shown on the Subcontract drawings, shall be considered simple shear connections and shall be designed and detailed in accordance with AISC-325. Substitution of sections or modification of connection details will not be accepted unless approved by the CONTRACTOR. High-strength bolting shall be in accordance with AISC S329 and meet the Suspect/Counterfeit Item (S/IC) requirements of DOE O 414.1C "Quality Assurance".

1.6.3 Non-Load-Bearing Metal Partition Wall Framing

Fabrication, installation, inspection, and qualification of Non-Load-Bearing Metal Partition Wall Frames shall meet the design criteria specified in WCH-56, "General Design Criteria for River Corridor Closure Contract" using AISC 360 Design Guides and Practices unless otherwise specified in the Subcontract.

Interior, non-load-bearing metal partition wall framing shall be installed by a SUBCONTRACTOR experienced in the installation of light gauge metal stud framing. The SUBCONTRACTOR shall be responsible for workmanship that conforms to AISC Code of Standard Practice for Steel Building and Bridges, AISC 303-05.

1.7 WELDING PROCEDURE QUALIFICATIONS

Except for prequalified procedures and previously qualified procedures submitted under Section 1.5, each welding SUBCONTRACTOR shall qualify the welding procedure specification (WPS) for any welding procedure followed in the fabrication of weldments as detailed in shop and/or erection drawings.

1.7.1 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this Subcontract without requalification if the following conditions are met:

- a. Testing was performed by an approved testing laboratory, technical consultant, or the SUBCONTRACTOR's approved program CQC program.
- b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this Subcontract.
- c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this Subcontract.

1.7.2 Prequalified Procedures

Welding procedures that are considered prequalified as specified in AWS D1.1 will be accepted without further qualification.

1.8 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

Each welder, welding operator, and tacker assigned to work on this Subcontract shall be qualified in accordance with the applicable requirements of AWS D1.1 and as specified in this section.

1.8.1 Previous Qualifications

At the discretion of the CONTRACTOR, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this Subcontract without requalification if the following conditions are met:

- a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are on file with the SUBCONTRACTOR.
- b. An approved testing laboratory, technical consultant, or the SUBCONTRACTOR's approved quality assurance program performed testing.
- c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this Subcontract.
- d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this Subcontract.

1.8.2 Certificates

Welder, welding operator, or tacker certification documentation submitted under Section 1.5 shall contain:

- the type of welding and positions for which the welder, welding operator, or tacker is qualified,
- the code and procedure under which the individual is qualified,
- the date when the welder, welding operator, or tacker was qualified, and
- the name of the firm and person certifying the qualification tests.

The certification shall be kept on file with the SUBCONTRACTOR. The certification shall be kept current for the duration of the Subcontract.

1.8.3 Renewal of Qualification

Requalification of a welder or welding operator shall be required under any of the following conditions:

- a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.
- b. There is specific evidence to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.
- c. The welder or welding operator was qualified by an employer other than those firms performing work under this Subcontract, and a qualification test has not been taken within the past 12 months.
- d. A tacker who passes the qualification test shall be considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific evidence to question the tacker's ability. In such a case, the tacker shall be required to pass the AWS D1.1 requirements.

1.9 INSPECTOR QUALIFICATION

Inspection and nondestructive testing personnel shall be qualified in accordance with the requirements of ASNT-01 for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT-01, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

1.10 WELD SYMBOLS

Weld Symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

1.11 SAFETY

Safety precautions during welding shall conform to ANSI Z49.1 and OSHA 1926.

2.0 MATERIAL GRADE QUALITY AND EQUIPMENT

2.1 WELDING EQUIPMENT AND MATERIALS

Welding equipment, electrodes, welding wire, consumables, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator performing

qualified welding procedures. Welding equipment and materials shall comply with the applicable requirements of AWS D1.1.

2.2 STRUCTURAL STEEL

Carbon grade steel shall conform to the requirements of ASTM A36/A36M, A529/A529M, A572, or A992.

2.3 HIGH STRENGTH BOLTS

High strength bolts shall conform to ASTM A325 or ASTM A490 and meet the Suspect/Counterfeit Item (S/IC) requirements of DOE O 414.1C "Quality Assurance".

2.4 CARBON STEEL BOLTS

Carbon steel bolts shall conform to ASTM A 307, Grade A or ASTM A325.

2.5 CARBON STEEL NUTS

Carbon steel nuts shall conform to ASTM A 563, Grade A, Hex.

2.6 WASHERS

Plain washers shall conform to ASTM F 844. Other types, when required, shall conform to ASME B18.21.1.

2.7 METAL STUDS, TRACKS AND ACCESSORIES

Cold-rolled steel 20-gauge galvanized C-studs with 1-5/8-in. flanges, shall conform to ASTM C645.

3.0 EXECUTION

3.1 WELDING OPERATIONS

3.1.1 Requirements

Workmanship and techniques for welded construction shall conform to the requirements of AWS D1.1 and AISC 360. Where AWS D1.1 and the AISC 360 specification conflict, the requirements of AWS D1.1 shall govern.

3.1.2 Weld Identification

Welds shall be identified in one of the following ways:

- a. Written weld records shall be submitted to the CONTRACTOR which indicate the location of welds made by each welder, welding operator, or tacker.
- b. Each welder, welding operator, or tacker shall be assigned a number, letter, or symbol to identify welds made by that individual. The welders, welding operators, and tackers apply their symbol next to the welds performed by them by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that that does not alter the structural property of the area. For seam welds, the identification mark shall be adjacent to the weld at approximately 1 meter (3-foot) intervals. Identification with die stamps or electric etchers shall not be allowed.

3.2 STANDARDS OF ACCEPTANCE

Dimensional tolerances for welded construction, details of welds and quality of welds shall be in accordance with the applicable requirements of AWS D1.1 and the Subcontract drawings. Nondestructive Evaluation (NDE) shall be the primary method of ensuring structural integrity. The SUBCONTRACTOR'S CQC Plan shall include proposed inspection methods for noted details for CONTRACTOR approval. The minimum extent of nondestructive testing shall be a random 25 percent of welds or joints.

Destructive evaluation can be applied as a means to ensure part structural integrity.

3.2.1 Nondestructive Examination

The welding shall be subject to inspection and tests in the mill, shop, and field as outlined in the SUBCONTRACTOR'S CQC Plan and QAP. Inspection and tests in the mill or shop will not relieve the SUBCONTRACTOR of the responsibility to furnish weldments of satisfactory quality. When material quality or workmanship do not conform to the SUBCONTRACTOR'S CQC Plan or QAP, the CONTRACTOR reserves the right to reject any material lot and/or workmanship at any time before final acceptance of the structure containing the weldment.

3.2.2 Destructive Tests

Destructive evaluation should only be used to ensure structure integrity as practicable. A formal review process initiated by the SUBCONTRACTOR shall be conducted prior to conducting the test as feasible. This review process should be included in the SUBCONTRACTOR'S CQC Plan.

Destructive tests can be performed off-site. When metallographic specimens are removed from any part of a structure, the SUBCONTRACTOR shall make repairs to ensure structural integrity where the specimens were removed. The SUBCONTRACTOR shall employ qualified welders or welding operators, and shall use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

3.3 VERIFICATION, VALIDATION, AND RECORD KEEPING

3.3.1 CONTRACTOR Verification and Validation

In addition to the QA/QC practices performed by the SUBCONTRACTOR to ensure structural integrity, the CONTRACTOR will perform inspection and acceptance testing to the extent determined by the CONTRACTOR. The costs of such inspection and testing will be borne by the SUBCONTRACTOR if unsatisfactory welds are discovered, or by the CONTRACTOR if the welds are satisfactory. The work may be performed by the CONTRACTOR or another SUBCONTRACTOR under a separate subcontract. The CONTRACTOR reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

3.3.2 Inspection Records

Inspection records and test reports shall be submitted for record prior to shipment and shall include:

- a. Inspection of welds,
- b. Inspection of blast cleaning and coating equipment,
- c. Inspection of surfaces to be blast cleaned and surfaces to be coated,
- d. All other Non-destructive Evaluation (NDE) test performed by SUBCONTRACTOR, and
- e. Coating tests.

3.3.3 Notifications

Notification of shop inspection of witness points is required for the following times:

- a. Start of NDE,
- b. Start of blast cleaning, and
- c. Start of coating inspection.

Notification shall be given verbally and in writing a minimum of two days prior to material availability for shop inspection.

3.4 CORRECTIONS AND REWORK

When inspection or testing indicates defects in the weld joints, the welds shall be reworked using a qualified welder or welding operator as applicable. Corrections shall be in accordance with the

requirements of AWS D1.1 and the specifications. Defects shall be reworked in accordance with the approved procedures. Defects discovered between passes shall be reworked before additional weld material is deposited. Wherever a defect is removed and rework by welding is not required, the affected area shall be blended into the surrounding surface to eliminate sharp notches, crevices, or corners.

After a defect is thought to have been removed, and before rewelding, the area shall be examined by suitable methods to insure that the defect has been eliminated. Reworked welds shall meet the inspection requirements for the original welds. Any indication of a defect shall be regarded as a defect, unless reevaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

3.5 STRUCTURAL STEEL FABRICATION

Fabrication shall be in accordance with the applicable provisions of the AISC 360. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC quality certification program for Category I supplement structural steelwork. Compression joints depending on contact bearing shall have a surface roughness not in excess of 12.7 micrometer (500 micro in.) as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6. Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with the AISC 360 and primed with the specified paint.

3.6 STRUCTURAL STEEL ERECTION

Erection of structural steel shall be in accordance with the applicable provisions of the AISC 360.

3.6.1 Connections

Anchor bolts and other connections between the structural steel and foundations shall be provided and shall be properly located and built into connecting work.

3.6.2 Base Plates and Bearing Plates

Column base plates for columns and bearing plates for beams, girders, and similar members shall be provided. Base plates and bearing plates shall be provided with full bearing after the supported members have been plumbed and properly positioned, but prior to placing superimposed loads. Separate setting plates under column base plates will not be permitted. The area under the plate shall be damp-packed solidly with bedding mortar, except where non-shrink grout is indicated on the drawings. Bedding mortar and grout shall be as specified in the Specification No. 0600X-SP-C0070 Reinforced Concrete.

3.6.3 Field Welded Connections

Field welded structural connections shall be completed before load is applied.

3.6.4 Field Priming

After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.7 METAL WALL FRAMING ERECTION

3.7.1 Tracks

Attach metal runner tracks to floor slabs with ¼" minimum diameter drilled-in expansion anchors located 2-inches from each end and spaced not more than 24 inches on center (OC). Provide double track (deflection head) at top of wall to allow ¾-inch deflection of framing. Attach to metal building framing with appropriate self tapping screws. Metal runner to floor slabs/foundation joint shall be sealed.

3.7.2 Studs and Other Framing

Installation shall conform to the requirements of ASTM C754. Stud spacing will be 16" OC, unless otherwise noted on the drawings. No splicing of studs will be allowed. Studs will be positioned vertically, and will engage floor and ceiling tracks, and be securely anchored to the track runners by welds, screws or bolts. Double full height studs will be placed on each side of wall openings and will be in direct contact with door and window frame jambs and will be securely anchored to the jamb and head anchor clips of door or window frames by bolt or screw attachment. Provide 20-gage header track with double channel stiffeners above and below each opening, secured to frame head anchors and double studs.

3.8 SHIPPING AND HANDLING

Shipping and handling for transport and storage shall be outlined in the SUBCONTRACTOR's Quality Assurance Program.

3.8.1 Transport Packaging

All packing, crating, blocking, and bracing shall be adequate to prevent damage to the fabricated material while loading, transport and unloading.

3.8.2 Use of Strapping and Wood Supports for Storage and Shipment

Coated steel shall rest on untreated wooded supports during shop storage and shipment. If it is necessary to stack members, untreated wooden separators shall be used. Coated steel shall at no time be placed directly on other steel, the ground, pavement, or other surface that could damage

the steel or the coating. Take precautions to prevent damage to coatings on the surface of the steel.

3.8.3 Shipping and Storage of Coating Materials

Coating materials shall be shipped and stored in accordance with the provisions of this specification.

3.8.4 Material Safety Data Sheets, Drawings, and Bill of Materials

One complete set of erection drawings, shop detail drawings, and bolt list shall accompany the first steel shipment.

Material Safety Data Sheets should be included in the drawing shipment.

3.8.5 Part Marking of Raw Materials

Prior to shipment, all pieces shall be clearly marked indicating the piece number, shop detail or erection drawing number, and other information needed for identification. Marks shall be visible when material is stacked. One members exceeding 9.14m (30 feet) in length, marks shall be placed at both ends and at approximate 6.09m (20') intervals. Material improperly detailed, mismarked, or incorrectly fabricated, so that its erection in the field necessitates extra work, shall be subject to rejection and shall be replaced at no additional cost to CONTRACTOR.

3.9 CONSTRUCTION QUALITY CONTROL AND QUALITY ASSURANCE

Construction Quality Control (CQC) and testing requirements are provided in Specification No. 0600X-SP-G0037. Quality Assurance Program (QAP) requirements are provided in Specification No. 0600X-SP-G0038.

(WPS)rework. A Material Review Process shall be included in the SUBCONTRACTOR's Quality Assurance Plan (QAP) to address non-conformance issues. The material review process shall include a process that furnishes copies in duplicate of the Non-Conformance report, Corrective Action and Error prevention. The CONTRACTOR shall be notified of any non-conformance within 1 working day.

The CONTRACTOR shall also be given copies of test and inspection records within 1 working day for verification & validation concurrence.

ELECTRICAL WORK

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ELECTRICAL WORK

1.0 GENERAL

1.1 SUMMARY

This specification establishes quality and workmanship requirements and defines how quality is measured for Electrical Work

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
DOE	Department of Energy
FS	Federal Specifications
IEEE	Institute of Electrical and Electronic Engineers
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters Laboratories
QAP	Quality Assurance Plan
QA/QC	Quality Assurance/Quality Control
SSRS	Subcontractor/Supplier Submittal Requirements Summary

1.3 REFERENCES

DOE 6430.1A, DIV 16	United States DOE General Design Criteria, Electrical
IEEE Std 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE Std 100	IEEE Standard Dictionary of Electrical and Electronics Terms
CFR 47 Part 18	Industrial, Scientific, and Medical Equipment

1.4 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Electrical Work. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Electrical Work. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ANSI C80.1	Electrical Rigid Steel Conduit (ERSC)
ANSI C119.1	American national Standard for electrical Connectors -Sealed Insulated Underground Connector Systems Rated 600 Volts
ASTM A 123/A 123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM B 8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	Standard Specification for Salt Spray (Fog) Apparatus
FS L-C-530	Coating, Pipe, Thermoplastic Resin
FS L-P-387	Plastic Sheet, Laminated, Thermosetting (for Designation Plates)
FS W-S-610/ A-A-59213	Splice Connectors
IEEE C62.41	IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IEEE C2	National Electrical Safety Code
IEEE C57.12.50	American national Standard Requirements for Ventilated Dry-Type Distribution Transformers, 1 to 500 kVa, Single-Phase, and 15 to 500 kVa, Three-Phase, With High Voltage 601 to 34 500 Volts, Low Voltage 120 to 600 Volts
ANSI/NEMA FB 1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures
NEMA ICS 1	Industrial Control and Systems: General Requirements
NEMA ICS 2	Industrial Control and Systems: Controllers, Contactors, and overload Relays Rated 600 Volts

NEMA ICS 3	Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC
NEMA ICS 6	Industrial Control and Systems: Enclosures
NEMA MG 1	Motors and Generators
NEMA MG 10	Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA OS 1	Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	Panelboards
NEMA RN 1	Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA WD 1	General Color Requirements for Wiring Devices
NEMA WD 6	Wiring Devices - Dimensional Requirements
NEMA TC 7	Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
NFPA 70	National Electrical Code
NFPA 70E	Standard for Electrical Safety in the Workplace
NFPA 101	Life Safety Code
UL 1	Flexible Metal Conduit
UL 6	Electrical Rigid Metal Conduit - Steel
UL 20	General-Use Snap Switches
UL 44	Thermoset-Insulated Wires and Cables
UL 50	Enclosures for Electrical Equipment
UL 67	Panelboards
UL 83	Thermoplastic-Insulated Wires and Cables

UL 98	Enclosed and Dead-Front Switches
UL 360	Liquid-Tight Flexible Steel Conduit
UL 467	Grounding and Bonding Equipment
UL 486A/486B	Wire Connectors
UL 486C	Splicing Wire Connectors
UL 489	Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 508	Industrial Control Equipment
UL 510	Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	Standard for Safety for Fuseholders
UL 514A	Metallic Outlet Boxes
UL 514B	Conduit, Tubing, and Cable Fittings
UL 542	Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 651	Schedule 40 and 80 Rigid PVC Conduit
UL 719	Non-Metallic Sheathed Cables
UL 845	Motor Control Centers
UL 869A	Reference Standard for Service Equipment
UL 935	Fluorescent Lamp Ballasts
UL 943	Ground-Fault Circuit Interrupters
UL 1030	Sheathed Heating Element
UL 1004	Electric Motors
UL 1029	High-Intensity-Discharge Lamp Ballasts
UL 1561	Dry-Type General Purpose and Power Transformers

UL 1660

Liquid-Tight Flexible Nonmetallic Conduit

1.5 DEFINITIONS

Electrical and electronic terms used in this specification are as defined in IEEE Std 100.

1.6 TECHNICAL SUBMITTALS

All required Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "T", Subcontractor/Supplier Submittal Requirements Summary (SSRS). A summary of all required submittals will be assembled and listed in Exhibit "T". Submittals that do not meet the project requirements will be rejected. Rejected submittals shall be resubmitted in a timely manner to avoid delays.

1.6.1 Factory Test

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests specified in applicable publications or in these specifications. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

1.6.2 Field Testing

A proposed field test plan, 20 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

1.6.3 Test Reports

Three copies of the information described below in 215.9 mm by 279.4 mm (8 1/2 by 11 in.) binders having a minimum of 3 rings from which material may readily be moved and replaced, including a separate section for each test. Heavy plastic dividers with tabs shall separate sections.

- a. A list of equipment used, with calibration certifications.
- b. A copy of all measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

1.6.4 Cable Installation Reports

Three copies of the information described below in 215.9 mm by 279.4 mm (8 1/2 by 11 in.) binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each cable pull. Heavy plastic dividers with tabs shall separate sections, with data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with all cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer of and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The lengths of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

1.6.5 Operation and Maintenance Manuals

Three copies of Operation and Maintenance manuals, within 7 calendar days following the completion of test and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide that lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent Subcontract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.7 SERVICE CONDITIONS

Items provided under this section shall be specifically suitable for the following service conditions:

- a. Altitude 213 m (700 ft)
- b. Ambient Temperature minus 20 degrees C (minus 5 degrees F) to 43 degrees C (110 degrees F)
- c. Frequency 60 Hz
- d. Seismic Zone 2B

1.8 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the SUBCONTRACTOR when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

2.0 MATERIALS AND EQUIPMENT

2.1 STANDARD PRODUCT

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacturer of the product and shall essentially duplicate items that have been in satisfactory use for at least two years prior to bid opening. Use shall include applications of equipment and materials under similar circumstances and of typical design and rating. Items of the same classification shall be identical. Equipment items provided shall be capable of being serviced by an organization that is, in the opinion of the CONTRACTOR, reasonably convenient to the site.

2.2 NAMEPLATES

2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be provided for transformers, circuit breakers, meters, switches, and lighting panels as shown on the drawings.

In addition; all new conduits shall have a permanent label attached at each end and at intermediate enclosures with the conduit's unique identifier. New manholes shall have a permanent label attached to the cover with its unique identifier.

2.3 CORROSION PROTECTION

2.3.1 Aluminum Materials

Aluminum shall not be used.

2.3.2 Ferrous Metal Materials

2.3.2.1 Hardware Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153 and ASTM A 123.

2.3.3 Equipment

Equipment and component items shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of

paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm (1/16 in.) from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.3.4 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in the Technical Specification for Coatings and Finishes.

2.4 CABLES AND WIRES

Conductors in cables shall be annealed copper. Cables shall be single-conductor Class B stranded type, unless otherwise indicated. Cables and wires shall conform to UL 44 for rubber-insulated type; UL 83 for the thermoplastic-insulated type; and UL 719 for the nonmetallic-sheathed cables.

2.4.1 Conductor Material

Underground cables shall be of soft drawn copper conductor material.

2.4.2 Low-Voltage Cables

2.4.2.1 In Duct Cables shall be single-conductor cable, Type XHHW in accordance with NFPA 70. Cables in factory-installed, coilable-plastic-duct assemblies shall conform to NEMA TC 5 or NEMA TC 7

2.4.3 Grounding Cables

See Grounding section of this specification.

2.5 CABLE JOINTS, TERMINATIONS, AND CONNECTORS.

2.5.1 Low-Voltage Cable Splices

Low-voltage cable splices and terminations shall be rated at not less than 600 Volts. Splices in conductors No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A. Splices in conductors No. 8 AWG and larger shall be made with noninsulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. Splices shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket. Splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

2.6 CONDUIT AND DUCTS

Duct lines shall be concrete-encased unless specified or shown otherwise. Single duct low-voltage lines or communication lines may be direct-burial.

2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.6.1.1 Concrete Encased Ducts. UL 651 Schedule 40.

2.6.1.2 Direct Burial, floor slab and walls. UL 651 Schedule 80.

2.6.2 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients.

Compounds shall have no injurious effect upon the hands of workmen or upon materials. Compound shall not have any injurious effect on cables or wires insulation or jacket routed through the sealing compound. Compound shall be evaluated for any effects on ampacities of cable or wires that would require a correction factor be applied.

2.7 PULLBOXES

Pullboxes shall be of type and size as shown on drawings. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers. Frames and covers shall be galvanized.

2.8 GROUNDING

2.8.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 C135.30 not less than 16 mm (5/8 in.) in diameter by 2.5 m (8 ft) in length or as shown on drawings. Sectional type rods may be used.

2.8.2 Grounding Conductors

Grounding conductors shall be bare. Bare conductors shall be ASTM B 8 soft-drawn copper unless otherwise indicated. Aluminum is not acceptable.

2.9 CONCRETE AND REINFORCEMENT

Concrete shall be a minimum of 27.6 MPa (4000 psi) at 28 days. Concrete color shall be red. Concrete reinforcing shall be as shown on drawings and as specified in the Technical Specification for Reinforced Concrete.

2.10 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the CONTRACTOR when the electrical system is accepted. Two complete sets of special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

2.11 UNIT HEATERS (HORIZONTAL PROPELLER FAN TYPE)

2.11.1 Construction

Unit heaters shall have input wattage, voltage, phase, output wattage (Btu/hr output), cfm air delivery, number of steps, and mounting height as shown or as specified. Unit heaters 3 kW and larger shall be three-phase. Complete unit heater assembly shall comply with the requirements of UL 1025 and the requirements specified. Each unit heater shall be provided with terminals for control circuits and a single source of power as necessary. Control transformers, where required, shall be factory installed and of adequate capacity. Electrical load for three-phase heaters shall be balanced between phases. Maximum discharge air temperature shall not exceed 140 degrees F when inlet air temperature is 60 degrees F.

2.11.2 Heating Elements

Heater shall be rated 3 kW, 120/208 V, 3 phase. Heating elements shall consist of nickel-chromium heating wire embedded in magnesium-oxide insulating refractory and sealed in corrosion-resisting metallic sheath with fins. The ends of elements shall be sealed and enclosed in terminal box, and element sheath shall be mechanically pressed after filling to ensure maximum magnesium oxide compaction. Sheath and fins shall be cast aluminum or steel with fins brazed to sheath. Castings shall be free from defects of any nature. Steel sheath and fins shall be stainless steel or be corrosion protected by high-temperature ceramic coating. Heat transfer between sheath and fins shall be uniform. Fins shall be spaced a maximum of six per inch and fin surface temperature at any point shall not exceed 550 degrees F during normal operation. Elements shall be free from expansion noise and 60-cycle hum.

2.11.3 Enclosure

Heated fan, motor, and auxiliaries shall be contained in a housing. All metal surfaces of housing shall be not less than 18 US gauge. Housings shall have the manufacturer's standard factory baked enamel finish. All parts shall be rigidly braced with heavy steel plates or structural steel shapes to prevent vibration and maintain alignment. Housing design shall provide ready access to interior parts without unfastening housing from mounting bracket. Each unit heater shall develop the floor area coverage and air throw required by the heater layout shown. The floor area coverage and air throw data shall be included on the detail drawing submittal.

2.11.4 Louvers

Horizontal air discharge units shall have individually adjustable horizontal louvers to direct discharge air horizontally as desired. A louvered back, heavy grille, or wire guard shall be provided for inlet air. Vertical air discharge units shall be provided with individually adjustable louvers so that airflow pattern can be adjusted in all directions. Discharge cones or diffusers shall be substituted where required.

2.11.5 Fans and Motors

Fans shall be the propeller type direct connected to fan motor, dynamically balanced, and designed specifically for unit heater application and low noise level. Sleeve type bearings shall have ample provisions for lubrication and oil reservoir, and shall be effectively sealed against loss of lubrication and entrance of dirt. Ball and roller type bearings shall be sealed, self-aligning and permanently lubricated. Fan motor shall be totally enclosed; continuous duty with built-in manually reset thermal overload protection. Motors 1/2 horsepower and larger shall be three-phase unless otherwise shown. Single-phase motors shall be permanent split capacitor, capacitor-start, or shaded pole type. Motor shall operate from the same power supply as the heater, and at the same voltage unless a factory-furnished step-down transformer is provided. Motor speed shall not exceed 1800 rpm.

2.11.6 Limit Controls

Manual reset thermal overheat protection of unit shall be provided to protect against overheating of the unit and mounted in a convenient location.

2.11.7 Contactor

Unit shall have factory-installed magnetic contactor, for remote thermostatic operation, which shall disconnect all ungrounded conductors to the heater. Contactor shall be rated for 100,000 cycle duty. A control transformer shall be provided when necessary to supply 120-volt thermostat control circuit for each heater.

2.11.8 Remote Controls

Room thermostat for pilot duty shall be internal to the unit. Thermostat shall have an approximate range of from 55 to 85 degrees F and an operating differential of 3 degrees F or less. Provide a non-fused safety disconnect switch near the heater as shown.

2.11.9 Wiring

Unit heaters shall be furnished complete, factory prewired to terminal strips, ready to receive branch circuit and control connections.

2.12 EXHAUST FANS

2.12.1 General

Fans shall include all units shown and shall be 1/2 HP, 115 VAC, single-phase propeller type. Fans shall be complete with motors, safety cages, vibration isolators, and necessary accessories. Fans shall be suitable for continuous operation. Exhaust fans shall be supported on metal frames for mounting, with safety guards. Wall openings and louvers shall be of sufficient size for the fan capacity.

2.12.2 Remote Controls

Exhaust fans shall be operated remotely by a wall thermostat located as shown on drawings. Thermostat range shall be a minimum of 24 degrees C (75 degrees F) to 43 degrees C (110 degrees F). Thermostats shall be HP rated for controlling the fans specified.

2.13 CIRCUIT BREAKERS

Circuit breakers shall have voltage, current and interrupting ratings as indicated.

2.13.1 Molded-Case and Insulated-Case Circuit Breakers

NEMA AB 1 and UL 459 for circuit breakers,

Molded-Case Circuit Breakers: Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multipole breakers shall be of the common-trip type having a single operating handle, but for sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multipole unit having an internal, mechanical, nonamperable common-trip mechanism and external handle ties. Breakers shall have interchangeable, adjustable magnetic trips in 225 amperes frame and larger. Breakers coordinated with current-limiting fuses shall have a combined interrupting capacity of 100,000 symmetrical amperes. All poles of associated breakers shall open if any fuse blows.

2.14 CONDUIT AND TUBING

2.14.1 Flexible Conduit, Steel and Plastic

General-purpose type, UL 1; liquid tight, UL 360, and UL 1660

2.14.2 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.14.3 Rigid Zinc-Coated Steel

UL 6.

2.14.4 Rigid Plastic

NEMA TC 2, UL 651 and UL 651A

2.15 CONDUIT AND DEVICE BOXES AND FITTINGS

2.15.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A

2.15.2 Boxes, Switch (Enclosed), Surface-Mounted

UL 98.

2.15.3 Fittings for Conduit and Outlet Boxes

UL 514B.

2.15.4 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.16 CONDUIT COATINGS PLASTIC RESIN SYSTEM

FS L-C-530 or NEMA RN 1, Type A-40

2.17 CONNECTORS, WIRE PRESSURE

2.17.1 Copper Conductors

UL 486A

2.18 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467

2.19 ENCLOSURES

NEMA ICS 6 or NEMA 250 unless otherwise specified

2.19.1 Cabinets and Boxes

UL 50

2.20 LUMINAIRES, LIGHTING, AND FIXTURE ACCESSORIES/COMPONENTS

Luminaires, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

2.20.1 Fluorescent

- a. **Fixture:** UL 1570. Luminaires shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles.
- b. **Electronic Ballast.** Electronic ballasts shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating and shall contain no PCBs. Ballasts shall meet CFR 47 Part 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A, unless otherwise indicated; the minimum number of ballasts shall be used to serve each individual fixture, using two lamp ballasts. A single ballast may be used to serve multiple luminaires if they are continuous mounted, factory manufactured for that installation with an integral wireway and are identically controlled.
- c. **Lampholders, Starters, and Starter Holders:** UL 542.

2.20.2 High-Intensity-Discharge

- a. **High-intensity-discharge lamps** shall be the high-pressure sodium type unless otherwise indicated, shown, or approved.
- b. **Ballasts:** ANSI C82.4 for multiple supply types and UL 1029.

2.21 FUSES AND FUSEHOLDERS

2.21.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.21.2 Fuseholders

UL 512.

2.22 MOTORS, AC, FRACTIONAL AND INTEGRAL HORSEPOWER

Motors, ac, fractional and integral horsepower shall conform to NEMA MG 1 and UL 1004 for motors; and NEMA MG 10 for energy management selection of polyphase motors. Polyphase motors shall comply with NEMA Design B. Single-phase motors 1/8 hp and smaller shall be shaded pole or permanent split capacitor; those larger than 1/8 hp shall be capacitor start. Submersible motors shall conform to applicable NEMA MG 1 standards and shall be as specified under driven equipment specifications.

2.22.1 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip-proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Motor Efficiency

<u>HP</u>	<u>Std. Efficiency</u>	<u>High Efficiency</u>
1	77.0	85.5
1.5	78.5	85.5
2	78.5	85.5
3	78.5	88.5
5	82.5	88.5
7.5	84.0	90.0
10	85.5	90.0
20	87.5	92.0

2.22.2 Motor Controls and Motor Control Centers

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Motor control

2.23 PANELBOARDS

Dead-front construction, NEMA PB 1 and UL 67

2.24 RECEPTACLES

2.24.1 Ground Fault Interrupters

UL 943, Class A.

2.25 SERVICE EQUIPMENT

UL 869A

2.26 SPLICE, CONDUCTOR

UL 486C

2.27 SNAP SWITCHES

UL 20

2.28 TAPES

2.28.1 Plastic Tape

UL 510

2.28.2 Rubber Tape

UL 510

2.29 TRANSFORMERS

2.29.1 Conventional Dry-Type

UL 1561 in addition to the specific standards referenced below.

- a. General Purpose: Ventilated, 15 to 500 kVA, three-phase with high-voltage and low-voltage 120-600 volts.

2.30 WIRING DEVICES

NEMA WD 1 for general-purpose wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

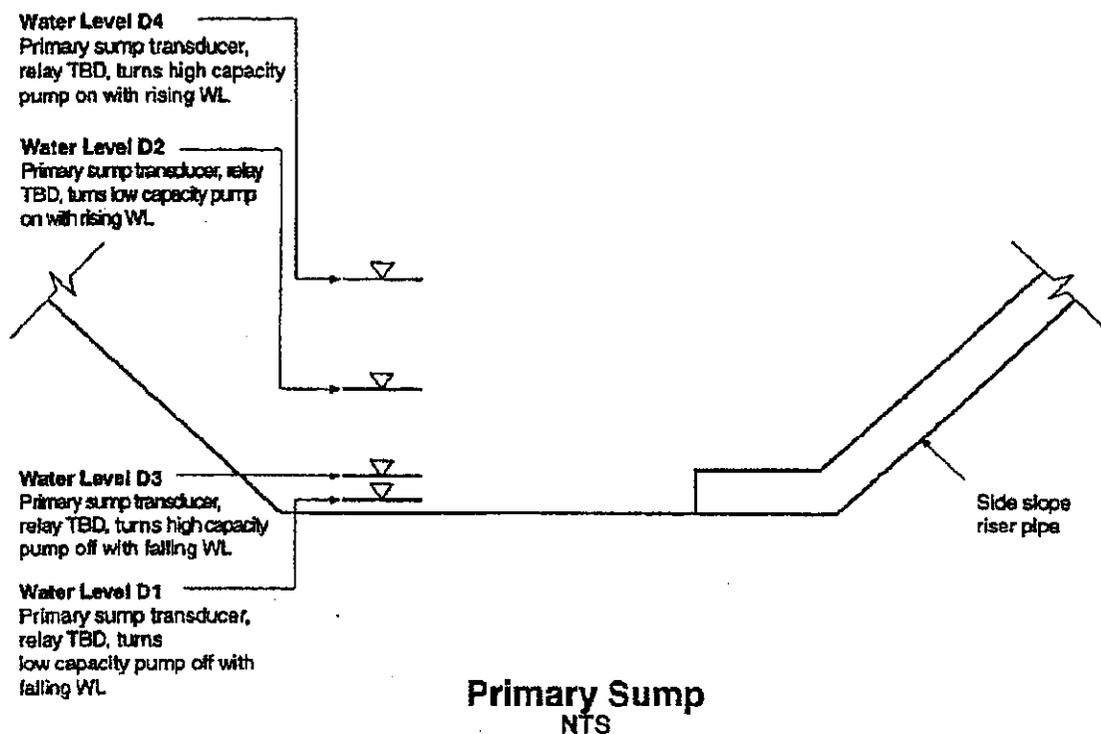
2.31 LEVEL MEASUREMENT

2.31.1 Submersible Transducer for Sumps

System shall use a submersible transducer with a pressure sensing range suitable for a depth application of 0.30 to 3.0 meters (1 to 10 ft). Transducer shall provide a 4-20 ma output to a digital monitor/controller for level monitoring and control with 2 adjustable setpoint relay outputs. Transducer shall be provided with a cable of unspliced length sufficient to route to the monitor/controller. Monitor/controller shall provide two relay outputs.

Transducer shall be Type LH-10 submersible liquid level transmitter and transducer as manufactured by WIKA Instrument Corporation or as approved.

Pump ID	Description	Function	Water Level	Level Above Sump Floor (ft)
Pump-1	Primary Sump High Capacity Pump	Pump Start	D4	2.00
Pump-1	Primary Sump High Capacity Pump	Pump Stop	D3	1.20
Pump-2	Primary Sump Low Capacity Pump	Pump Start	D2	1.30
Pump-2	Primary Sump Low Capacity Pump	Pump Stop	D1	0.80
Pump-2	Secondary Sump Low Capacity Pump	Pump Start	D2	1.30
Pump-2	Secondary Sump Low Capacity Pump	Pump Stop	D1	0.80



2.32 DATA LOGGER

2.32.1 Crest Pad Building Leachate Primary and Secondary Level

System shall use a Blancett Model CS-51 data logger, dual channel 4-20 ma input, powered by 115 VAC. Logger shall record the leachate levels in the primary sump and the secondary sump.

2.33 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A programmable logic controller (PLC) system shall be used to monitor and control of the leachate system. The PLC system shall match the Allen-Bradley SLC 500 modular system installed in the Cells 5&6 crest pad buildings. Information regarding the PLC system installed in Cells 5&6 is included in the *Information to Offerors* provided with the request for proposal (RFP) for this project. The following SLC 500 modular components were installed in Cells 5&6.

- A-B 1747-L514, Modular Processor
- A-B 1746-P2, Power Supply
- A-B 1746-A7, 7 Slot Chassis
- A-B 1746-IA17 & 1746-OX8, Discrete I/O Module
- A-B 1746-N14, Analog I/O Module
- RSLogix500 PLC Program

3.0 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements for conduit systems Below Slab-on-Grade or In the Ground of this specification. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of the Technical Specification for Site Work.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70, NFPA 70E, NFPA 101, IEEE C2, OSHA 29CFR1910 and DOE-STD-1066-99 as applicable.

3.1.2 Verification of Work, Dimensions, and Construction Sequencing

The SUBCONTRACTOR shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the CONTRACTOR of any discrepancy before performing any work. The SUBCONTRACTOR shall carefully examine all work to be done in, on, or adjacent to existing equipment. Work shall be scheduled, subject to the CONTRACTOR's approval, to avoid plant shutdown, all switching, safety tagging, etc. required to isolate existing equipment shall be performed by the SUBCONTRACTOR. In no case shall the

SUBCONTRACTOR begin any work in, on, or adjacent to existing equipment without written authorization by the CONTRACTOR. The SUBCONTRACTOR shall make modifications or alterations to existing electrical facilities required to successfully install and integrate the new electrical equipment as indicated. All modifications to existing equipment, panels, or cabinets shall be made in a professional manner with coatings repaired to match existing. The costs for modifications to existing electrical facilities required for a complete and operating system shall be included in the SUBCONTRACTOR's original bid amount and no additional payment for this work shall be authorized. The SUBCONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required by the drawings. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design as shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The SUBCONTRACTOR shall coordinate the electrical work with the drawings and provide all power related wiring even if not shown on the electrical drawings.

SUBCONTRACTOR will be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers. Costs for this work shall be included in the SUBCONTRACTOR's original bid amount. To facilitate continuous operation of existing equipment, the SUBCONTRACTOR will be required to provide temporary equipment as required to maintain the existing facility operation. All costs associated with these temporary installations shall be part of the original bid.

3.2 CABLE INSTALLATION

The SUBCONTRACTOR shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The SUBCONTRACTOR shall then perform pulling calculations and prepare a pulling plan that will be followed during cable installation.

3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of fiber, laminated plastic or non-ferrous metal tags, in each pullbox and each terminal. Identification shall match wire and cable numbers as shown on the as-built drawings. Wire and cables not numbered on drawings shall be labeled as directed by the CONTRACTOR.

3.2.1.1 Cable Inspection. The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.2 Duct Cleaning. Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 6.4 mm (1/4 in.) less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 131 cubic centimeters (8 cubic in.) of debris is expelled from the duct.

3.2.1.3 Duct Lubrication. The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacture's recommendations.

3.2.1.4 Cable Installation. The SUBCONTRACTOR shall provide a cable feeding truck and a cable pulling winch. The SUBCONTRACTOR shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manila rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The SUBCONTRACTOR shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 10 degrees C (50 degrees F) temperature for at least 24 hours before installation.

3.2.1.5 Cable Installation Plan. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.2.3 Electric Pullboxes

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation.

3.3 DUCT LINES

3.3.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m (4 in. per 100 ft). Depending on the contour of the finished grade, the high-point may be at a terminal, a pullbox, or between pullboxes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm (18 in.) for ducts of less than 80 mm (3-in.) diameter, and 900 mm (36 in.) for ducts 80 mm (3 in.) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m (25 ft) shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in pullboxes.

3.3.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.3.3 Concrete Encasement

Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement or pullbox, the new encasement shall be well bonded or doweled to the existing encasement. At any point tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. As shown duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loading. Separators or spacing blocks shall be made of concrete, plastic, or a combination of these materials placed not farther apart than 1.2

m (4 ft) on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm (6 in.) vertically. Ferrous materials or rebars shall not be used for securing and completely encircling a single duct.

3.3.4 Nonencased Direct-Burial

Top of duct lines shall be less than 762 mm (30 in.) below finished grade and shall be installed with a minimum of 75 mm (3 in.) of earth around each duct, except that between adjacent electric power and communication ducts, 300 (12 in.) of earth is required. Bottoms of trenches shall be graded toward pullboxes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 75 mm (3 in.) layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. The rest of the excavation shall be backfilled and compacted in 75 mm to 150 mm (3- to 6-in.) layers. Ferrous materials or rebars shall not be used for securing and completely encircling a single duct.

3.3.5 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.3.5.1 Plastic Duct. Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.3.6 Duct Line Markers

A 0.127 mm (5mil) brightly colored plastic tape, not less than 75 mm (3 in.) in width and suitably inscribed at not more than 3 m (10 ft) on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm (1 mil) metallic foil core to permit location of the duct line, shall be placed approximately 300 mm (12 in.) below finished grade levels.

3.4 PULLBOXES

3.4.1 General

Pullboxes shall be constructed approximately where shown. The exact location of each pullbox shall be determined after careful consideration has been given to the location of other utilities and grading. The location of each pullbox shall be approved by the CONTRACTOR before construction of the pullbox is started. In unpaved areas, the top of manhole covers shall be approximately 15 mm (1/2 in.) above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. Where duct lines enter manholes, the sections of duct may be either cast in the concrete or may enter the manhole through a square or rectangular opening of suitable dimensions provided in the manhole walls. Where openings are provided for the entrance of duct lines, the space between ducts and between

ducts and manhole walls shall be caulked tight with lead wool or approved equal. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.4.2 Electric Pullboxes

Cables shall be securely supported from walls by hot-dip galvanized cable racks and equipped with adjustable hooks and insulators. Cable racks shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks. Covers shall be marked "Low Voltage" and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

3.4.3 Signal Pullboxes

The number of hot-dip galvanized cable racks indicated shall be installed in each Signal Pullbox. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others. Each box shall have a suitable opening for a ground rod.

3.4.4 Ground Rods

A ground rod shall be installed at the pullboxes. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG tinned ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

3.5 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturers published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be carefully installed so as not to damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose.

3.5.1 Concrete Pads

3.5.1.1 Construction. Concrete pads for pad-mounted electrical equipment shall be poured-in-place. Pads shall be constructed as indicated except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the SUBCONTRACTOR. Tops of concrete pads shall be level and shall project 100 mm (4 in.) above finished paving or grade and sloped to drain. Edges of concrete pads shall have 20 mm (3/4 in.) chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection.

3.5.1.2 Conduit and Enclosure Sealing. When the installation is complete, the SUBCONTRACTOR shall seal all conduit and other entries into equipment enclosures, handholes, and manholes with an approved sealing compound. Seals shall be of sufficient strength and durability to protect energized live parts of the equipment from rodents, insects, or other foreign matter.

3.6 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 1.5 m (5 ft) outside of a building and 600 mm (2 ft) below finished grade. After installation of cables, conduits shall be sealed with caulking compound to prevent entrance of moisture or gases into buildings.

3.7 GROUNDING (UTILITY SIDE)

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer and a motor control center to the ground ring.

3.7.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 300 mm (1 ft) below finished grade.
- b. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed 450 mm (18 in.), plus or minus 75 mm, (3 in.), below finished top of soil grade. Ground ring conductors shall be sized as shown.
- b. Additional electrodes - Whenever the required ground resistance is not met, provide additional electrodes interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes will be 3, 2.5 m (8-ft) rods spaced a minimum of 1.8 m (6 ft) apart.

Each utility grounding system will be kept 6.9 m (20') from the site service grounding system.

3.7.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-

welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.7.3 Grounding and Bonding Conductors

Grounding and bonding conductors include all conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor and the opening shall be sealed with a suitable compound after installation.

3.7.4 Pullbox Grounding

Ground rods installed in electrical-distribution-system pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 50 mm (2 in.) above and 150 mm (6 in.) below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to pullbox walls and the amount of exposed bare wire shall be held to a minimum.

3.8 UNIT HEATERS AND EXHAUST FANS

Unit heaters and exhaust fans shall be installed at the locations shown and in accordance with the recommendations of the manufacturer. All hardware necessary for installation shall be provided and sufficiently anchored to meet seismic loading requirements of UBC zone 2B.

3.9 GROUNDING (SERVICE SIDE)

Grounding shall be in conformance with NFPA 70, the Subcontract drawings, and the following specifications.

3.9.1 Ground Bus

Ground bus shall be provided in the electrical equipment rooms. Non-current-carrying metal parts, transformer neutrals and other electrical equipment shall be effectively grounded by bonding to the bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.9.2 Grounding Conductors

All equipment grounding conductors shall be bonded or joined together in each wiring box or equipment enclosure. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When boxes for receptacles, switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3.10 WIRING METHODS

3.10.1 General Requirements

Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit or rigid plastic conduit.

3.10.2 Conduit Systems

Conduit systems shall be installed as indicated. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit may be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Electrical metallic tubing may be installed only within buildings. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of conduits and shall be of the insulating type, where required by NFPA 70.

3.10.2.1 Below Slab-on-Grade or In the Ground. All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel. Rigid steel conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.254 mm (0.010 in.) thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.10.2.2 Changes in Direction of Runs. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Care shall be taken to prevent the lodgment of dirt or trash in boxes, fittings and equipment during the course of construction.

3.10.2.3 Supports. Metallic conduits shall be securely and rigidly fastened in place at intervals of not more than 3 meters (10 ft) and within 900 mm (3 ft) of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, or ceiling trapeze. C-clamps or beam clamps shall have strap or rod-type retainers. Rigid plastic conduits (if permitted as a wiring method) shall be supported as indicated above, except that they will be supported at intervals as indicated in NFPA 70. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging. Fastenings shall be by expansion bolts on concrete; by machine screws,

welded threaded studs, heat-treated or spring-steel-tension clamps on steelwork. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Pipe straps shall not be welded to steel structures. In partitions of light steel construction, sheet-metal screws may be used. Conduit shall not be supported using wire or nylon ties. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by the NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered.

3.10.3 Cables and Conductors

Wire connectors of insulating material or solderless pressure connectors properly taped shall be utilized for splices.

3.10.3.1 Power Conductor Identification. Color-coding shall identify phase conductors. The color of the insulation on phases A, B, and C respectively (for three phase) or phases A and B respectively (for single phase) of different voltage systems shall be as follows:

- a. 120/208 volt, 3-phase: Black, red, and blue; white neutral, green or bare ground.
- b. 277/480 volt, 3-phase: Brown, orange, and yellow; gray neutral, green or bare ground.
- c. 120/240 volt, single/phase: Black and red; white neutral, green or bare ground.

Conductor phase and voltage identification shall be made by color-coded insulation for conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 75 mm (3 in.) of length near the end, or other method as submitted by the SUBCONTRACTOR and approved by the CONTRACTOR. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

3.10.3.2 Control Conductor Identification. Control circuit conductor identification shall be made by color-coded insulated conductors, plastic-coated self-sticking printed markers, permanently attached stamped metal foil markers, or equivalent means as approved. All control circuit terminals of equipment shall be properly identified with terminal and conductor identification matching that shown on drawings. When conductor identification is not shown, SUBCONTRACTOR shall provide identification list to the CONTRACTOR for approval. Hand lettering or marking is not acceptable.

3.11 BOXES AND SUPPORTS

Boxes shall be provided in the wiring systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic conduit and tubing or nonmetallic sheathed cable system, when permitted by NFPA 70. In partitions of light steel construction bar hangers with 25 mm (1 in.) long studs, mounted between metal wall studs or metal stud "C" brackets snapped on and tab-locked to metal wall studs, shall be used to secure boxes to the building structure. When "C" brackets are used, additional box support shall be provided on the side of the box opposite the brackets. The edges of boxes for electrical devices shall be flush with the finished surfaces in plywood installations. Boxes for mounting lighting fixtures shall be not less than 101.6 mm (4 in.) square. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. Unless otherwise indicated, boxes for wall switches shall be mounted 1.2 meters (46 in.) above finished floors. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes and supports shall be fastened with machine screws or welded studs on steelwork. Threaded studs driven in by powder charge and provided with lock washers and nuts, or nail-type nylon anchors may be used in lieu of machine screws. In open overhead spaces, cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Cast-metal boxes with 2.4 mm (3/32 in) wall thickness are acceptable.

3.11.1 Pull Boxes

Pull boxes of not less than the minimum size required by NFPA 70 shall be constructed of aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

3.11.2 Conduit Stub-Ups

Conduits stubbed up through concrete floors for connections to freestanding equipment shall be provided with a short elbow and an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 150 mm (6 in.) above the floor. Screwdriver operated threaded flush plugs shall be installed in conduits from which no equipment connections are made to suit the devices installed.

3.12 DEVICE PLATES

One-piece type device plates shall be provided for outlets and fittings. Plates on walls and on fittings shall be of zinc-coated sheet steel, cast-metal, or impact resistant plastic having rounded or beveled edges. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate.

Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plates shall be installed with an alignment tolerance of 16 mm (1/16 in.). The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

3.13 RECEPTACLES

3.13.1 Duplex

Duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke.

3.13.2 Weatherproof

Weatherproof receptacles shown shall be mounted in a box with a gasketed weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. The receptacle shall be weatherproof with plug inserted.

3.14 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall harmonize with the color of the respective wall. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than two switches shall be installed in a single-gang position. Switches shall be rated 20-ampere 120-volt for use on alternating current only.

3.15 SERVICE EQUIPMENT

Service-disconnecting means shall be of the fusible safety switch type as indicated with external handle for manual operation. When service-disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.16 PANELBOARDS AND LOADCENTERS

Circuit breakers and switches used as a motor disconnecting means, and not in sight of the motor and the driven machinery location, shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

3.16.1 Loadcenters

Loadcenters shall be circuit breaker equipped.

3.16.2 Panelboards

Panelboards shall be circuit breaker equipped as indicated on the drawings.

3.17 FUSES

Equipment provided under this Subcontract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

3.18 UNDERGROUND SERVICE CONDUITS

Empty conduits for underground electric-service cable and signal cable shall be installed as indicated. Except where otherwise indicated, conduits shall terminate approximately 1.5 meter (5 ft) beyond the building wall and 600 mm (2 ft) below finished grade, with the outside ends bushed and plugged or capped.

3.19 MOTORS

Fractional and Integral Kilowatt, (Horsepower), whether or not motors are separately provided or included in equipment assemblies specified in other sections of these specifications. Each motor shall conform to the kW (hp) and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 480-volt systems shall have a nameplate rating of 460 volts. Unless otherwise specified, motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on Subcontract drawings. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the SUBCONTRACTOR shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.20 MOTOR CONTROL

Each motor or group of motors requiring a single control and not controlled from a motor-control center shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 93

W (1/8 hp) or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate kilowatt (horsepower) rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for the manual control: when the automatic-control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low- or high-pressure cutouts, high-temperature cutouts, and motor-overload protective devices, shall be connected in the motor-control circuit in both the Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the CONTRACTOR unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.20.1 Motor Control Centers

Control centers shall be indoor type and shall contain combination starters and other equipment as indicated. Control centers shall be NEMA ICS 2, Class 1, Type 2. Each control center shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with circuit breakers. Motor control centers shall be provided with a full-length ground bus bar.

3.20.2 Contacts

Contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.21 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.22 TRANSFORMERS

Only transformers having two windings per phase will be approved. Three-phase transformers shall be connected only in a delta-wye. The insulation on transformer windings may be the manufacturer's standard for transformers rated for operation in a 40 degree C (104 degrees F) ambient temperature. Single kVA ratings shown are based on self-cooled operation. The basic impulse level (BIL) of individual transformers shall be as stated in the following paragraphs. The conventional dry-type transformer shown located within 1.5 meters (5 ft) of the exterior wall shall be provided in a weatherproof enclosure. The average sound level in decibels (dB) of transformers shall not exceed the 50 dB level.

3.22.1 Conventional Dry-Type Transformers

Transformers having the primary or higher-voltage winding rated at 600 volts or less and a secondary or lower-voltage winding rated at 240 volts or less may be manufacturer's standard ventilated or enclosed, self-cooled type of transformer unless otherwise shown, specified or required for proper and safe application.

3.23 LAMPS AND LUMINAIRES

3.23.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the luminaires just prior to the completion of the project.

3.23.2 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation. Open type fluorescent luminaires with exposed lamps shall have a wire-basket type guard,

3.24 EQUIPMENT CONNECTIONS

All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduit 6 feet or less in length shall be provided to electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.24.1 Motors and Motor Control

Control equipment shall be connected under this section of the specifications unless shown or specified otherwise.

3.25 SEISMIC SUPPORTS

Electrical equipment shall be installed with supports capable of withstanding a seismic 2B event as defined by the UBC.

3.26 PAINTING AND FINISHING

Field-applied paint on exposed surfaces shall be provided under the Technical Specification for Coatings and Finishes.

3.27 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, or other electrical work, this work shall be carefully done, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved, at no additional cost to the CONTRACTOR.

3.28 IDENTIFICATION NAMEPLATES

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with FS L-P-387 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the SUBCONTRACTOR shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the CONTRACTOR, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard and motor control center shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 6.4 mm (1/4 in.) High Letters

Panelboards
Starters
Safety Switches
Motor Control Centers
Transformers
Equipment Enclosures(Including Vaults)
Motors

Minimum 3.2 mm (1/8 in.) High Letters

Control Power Transformers
Control Devices
Unit Heaters

Each panel, section, or unit in motor control centers or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

3.29 FIELD TESTING

3.29.1 General

Field testing shall be performed in the presence of the CONTRACTOR. The SUBCONTRACTOR shall notify the CONTRACTOR 10 days prior to conducting tests. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and submission of test results to the CONTRACTOR. The SUBCONTRACTOR shall furnish materials, labor, and equipment necessary to conduct field tests, and the CONTRACTOR will furnish the necessary electrical power. The SUBCONTRACTOR shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the CONTRACTOR. The SUBCONTRACTOR shall maintain a written record of tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports shall be signed and dated by the SUBCONTRACTOR. The SUBCONTRACTOR shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.29.2 Safety

The SUBCONTRACTOR shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Safety requirements shall conform to NEPA 70E.

3.29.3 Ground-Resistance Tests

The resistance of each grounding electrode system shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Multiple rod electrodes - 5 ohms.
- c. Ground ring - 5 ohms.

3.29.4 Low-Voltage Cable Test

After installation, but just prior to terminal connection, low voltage cables shall be tested as follows:

- a. One thousand volt "Megger" test with all other conductors in each conduit or cable grounded. The final resistance of each conductor shall not be less than one (1) megohm.
- b. Continuity test of each conductor from terminal to terminal and phase identification check of power conductors.
- c. Suitable records shall be kept of tests, indicating the "Megger" readings, continuity test, and conductor identification markings. All tests shall be witnessed and signed by a Representative of the SUBCONTRACTOR. A duplicate record of all tests shall be furnished to the CONTRACTOR. Prior to testing, the SUBCONTRACTOR shall submit his test record form for approval of the CONTRACTOR.
- d. Any length of wires or cable failing under the above tests shall be replaced by the SUBCONTRACTOR at no additional cost to the CONTRACTOR.
- e. The SUBCONTRACTOR shall furnish instruments and personnel required to perform these tests.
- f. Tests shall be witnessed by a representative of the CONTRACTOR and the test form shall provide sufficient space for his signature.

3.30 MANUFACTURER'S FIELD SERVICE

3.30.1 Onsite Training

The SUBCONTRACTOR shall conduct a training course for the operating staff as designated by the CONTRACTOR. The training period shall consist of a minimum of 16 hours of normal working time and shall start after the system is functionally completed but prior to facility turnover. The course instruction shall cover pertinent points involved in operating, starting, stopping, and servicing the equipment, as well as all major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance operations.

3.30.2 Installation Engineer

After delivery of the equipment, the SUBCONTRACTOR shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

3.31 ACCEPTANCE

Final acceptance of the facility will not be given until the SUBCONTRACTOR has successfully completed tests and after all defects in installation, material or operation have been corrected and

SUBCONTRACTOR has met the requirements of the GENERAL CONDITIONS article titled "FINAL INSPECTION AND ACCEPTANCE".

3.32 QUALITY ASSURANCE/QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall maintain and submit to CONTRACTOR records including but not limited to the following:

- (1) Delivery, storage, and handling of devices and equipment used.
- (2) Conformance of materials to the requirements of these specifications.
- (3) Inspection of devices and equipment installed.
- (4) Field testing of devices and equipment.
- (5) Installation of devices and equipment to these requirements and applicable codes and standards.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be supplied to the CONTRACTOR within one working day of the inspection or test.

QUALITY CONTROL REQUIREMENTS

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QUALITY CONTROL REQUIREMENTS

1.0 GENERAL

1.1 SUMMARY

Construction Quality Control (CQC) is a planned system of inspections that is used to directly monitor and control the quality of a construction project. CQC refers to the measures taken by the SUBCONTRACTOR to determine compliance with the requirements for materials and workmanship as stated in the Drawings and Technical Specifications for the project.

1.2 DEFINITIONS AND ABBREVIATIONS

The definitions and abbreviations listed below, as used in this specification, shall have the following meaning:

ASTM	American Society for Testing and Materials
ATP	Acceptance Test Procedure
WCH	Washington Closure Hanford, LLC.
CQAP	Construction Quality Assurance Plan for Environmental Restoration Disposal Facility (ERDF) Cells 7 through 10. The CQAP describes the quality assurance activities to be performed by the CQA SUBCONTRACTOR to provide assurance that the project is constructed as specified. The CQAP is to function independently of the SUBCONTRACTOR'S Quality Control Program, although the SUBCONTRACTOR shall provide assistance and cooperation, including stoppage of Work, to the CQASUBCONTRACTOR.
CQC	SUBCONTRACTOR Construction Quality Control. CQC refers to the measures taken by the SUBCONTRACTOR to determine compliance with the requirements for materials and workmanship as stated in the Drawings and Technical Specifications for the project.
DOE	U.S. Department of Energy (Hanford Site)
EPA	U.S. Environmental Protection Agency
QAP	SUBCONTRACTOR Quality Assurance Program. The QAP shall describe the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing and assessing the work. The QAP shall be prepared in accordance with Specification No. 0600X-SP-G0038, Supplier Quality Assurance Program Requirements, to comply with GC-50, Quality Assurance Program, of the General Conditions.
QC	quality control
SSRS	Subcontractor/Supplier Submittal Requirements Summary
IWCP	Integrated Work Control Program

1.3 REFERENCES

DOE M 231.1-2 Occurrence Reporting and Processing of Operations Information

DOE SCRD M 231.1-2 Occurrence Reporting and Processing of Operations Information.

1.4 CODES, STANDARDS, LAWS, PROCEDURES, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Site Work. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Site Work. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM D 3740 Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

ASTM E 329 Standard Specification for Agencies Engaged in Construction Inspection and/or Testing

EPA/600/R-93/182 EPA, Technical Guidance Document, Quality Assurance and Quality Control for Waste Containment Facilities*

PAS-2-1.1 Integrated Work Control

PAS-2-1.2 Preventative Maintenance

PAS-2-2.2 Work Process Flow Diagrams

* Note that an update to EPA/600/R-93/182 has been published: Daniel, D.E. and Koerner, R. M. (2007). *Waste Containment Facilities: Guidance for Construction Quality Assurance and Construction Quality Control of Liner and Cover Systems*, second ed., ASCE, New York, NY, 351 pp.

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I," Subcontractor/Supplier Submittal Requirements Summary (SSRS). Rejected submittals shall be resubmitted to avoid delays.

2.0 QUALITY CONTROL

The SUBCONTRACTOR is responsible for quality control (QC) and shall establish and maintain an effective QC system in compliance with GC-31, Inspection, Quality Surveillance, and Rejection of Materials and Workmanship, GC-32, Testing, and GC-50, Quality Assurance

Program, of the General Conditions and EPA/600/R-93/182. The QC system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the contract requirements. The QC system shall cover construction operations, both on-site and off-site, and shall be keyed to the proposed construction sequence. The SUBCONTRACTOR'S Quality Control Program shall be consistent with and be incorporated into the SUBCONTRACTOR'S Quality Assurance Program.

Rework caused by failure to follow the Quality Control system shall be at the SUBCONTRACTOR'S expense.

Additional specifications and standards for the Work are specified in other sections of the Subcontract. These additional specifications and standards are "in addition to" those specified in this section. They do not relieve SUBCONTRACTOR from compliance with the Quality Control Requirements included in this section.

2.1 GENERAL

The SUBCONTRACTOR shall furnish for review by the CONTRACTOR the SUBCONTRACTOR Construction Quality Control (CQC) Plan proposed to implement the requirements described in this specification and in GC-31 Inspection, Quality Surveillance, and Rejection of Materials and Workmanship, and GC-32, Testing, of the GENERAL CONDITIONS. The CQC Plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. The CONTRACTOR will consider an interim plan for the first 30 days of operation. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of work to be started. Work outside of the features of work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of work to be started. The CQC Plan shall be incorporated into the QAP required by Specification No. 0600X-SP-G0038, Supplier Quality Assurance Program Requirements, and GC-50, Quality Assurance Program, of the General Conditions.

2.1.1 Content of the CQC Plan

The CQC Plan shall include, as a minimum, the following to cover construction operations, both on-site and off-site, including work by subtier subcontractors.

- a. A description of the QC organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the three phase control system for all aspects of the work specified. The staff shall include a CQC system manager who shall report to the project manager or someone higher in the SUBCONTRACTOR's organization. Project manager in this context shall mean the individual with responsibility for the overall management of the project including quality and production.
- b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.

- c. A copy of the letter to the CQC System Manager signed by an authorized official of the SUBCONTRACTOR which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the CQC System Manager including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various QC representatives outlining duties, authorities and responsibilities. Copies of these letters shall also be furnished to the CONTRACTOR.
- d. Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers and purchasing agents. These procedures shall be in accordance with Exhibit I.
- e. Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be subject to approval by the CONTRACTOR.)
- f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests including documentation.
- g. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures shall establish verification that identified deficiencies have been corrected.
- h. Reporting procedures, including proposed reporting formats.
- i. A list of the Definable Features of Work. A Definable Feature of Work is a task that is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a Definable Feature of Work, there is frequently more than one definable feature under a particular section. This list will be agreed upon during the coordination meeting.

2.1.2 Acceptance of Quality Control Plan

CONTRACTOR'S Acceptance of the SUBCONTRACTOR's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during construction. The CONTRACTOR reserves the right to require the SUBCONTRACTOR to make changes in his CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

2.1.3 Notification of Changes

After acceptance of the CQC Plan, the SUBCONTRACTOR shall notify the CONTRACTOR in writing a minimum of seven calendar days prior to any proposed change. Proposed changes are subject to acceptance by the CONTRACTOR.

2.2 COORDINATION MEETING

Before start of construction, and prior to acceptance by the CONTRACTOR of the Quality Control Plan, the SUBCONTRACTOR shall meet with the CONTRACTOR or Authorized Representative and discuss the SUBCONTRACTOR's QC system. During the meeting, a mutual understanding of the system details shall be developed, including the forms for recording the CQC operations, control activities, testing, administration of the system for both on-site and off-site work, and the interrelationship of SUBCONTRACTOR'S management and control with the CONTRACTOR's Quality Assurance inspection and the CQA SUBCONTRACTOR. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by the SUBCONTRACTOR.

2.3 QUALITY CONTROL ORGANIZATION

The SUBCONTRACTOR shall identify an individual within his organization at the site of the work who shall be responsible for overall management of CQC and have the authority to act in CQC matters for the SUBCONTRACTOR. This CQC System Manager shall be on the site during construction and shall be employed by the SUBCONTRACTOR, except as noted in the following. An alternate for the CQC System Manager shall be identified in the plan to serve in the event of the system manager's absence. The requirements for the alternate shall be the same as for the designated CQC System Manager.

2.3.1 CQC Organizational Staffing

A CQC staff shall be maintained under the direction of the CQC System Manager to perform Quality Control activities. The actual strength of the staff during any specific work period may vary to cover work phase needs, shifts, and rates of placement. The personnel of this staff shall be fully qualified by experience and technical training to perform their assigned responsibilities and have sufficient and well-defined authority to enforce quality requirements, to identify, initiate, recommend and provide solutions to quality problems, and to verify the effectiveness of the solutions. CQA staff shall be directly hired by and work for the SUBCONTRACTOR.

2.3.2 Organizational Changes

The SUBCONTRACTOR shall obtain CONTRACTOR's acceptance before replacing any member of the CQC staff. Requests shall include the names, qualifications, duties, and responsibilities of each proposed replacement.

2.4 DAILY QUALITY CONTROL (QC) REPORTS

SUBCONTRACTOR shall develop a daily Quality Control (QC) Report format as part of the CQC Plan. The QC Report shall contain, at a minimum, the items listed in the paragraph, DOCUMENTATION, below. The QC Report format shall be approved by the CONTRACTOR and shall be used by the SUBCONTRACTOR for all daily QC Reports. SUBCONTRACTOR shall summarize data from any supplemental reports by the SUBCONTRACTOR and consolidate onto the daily QC Report. The Daily QC Report shall be submitted to the CONTRACTOR in accordance with the requirements of paragraph, DOCUMENTATION, below.

2.5 CONSTRUCTION QUALITY CONTROL

Construction Quality Control is the means by which the SUBCONTRACTOR ensures that construction, to include that of subcontractors and suppliers, complies with the requirements of the contract. The controls shall be adequate to cover construction operations, and shall be keyed to the proposed construction sequence. At least three phases of control shall be conducted by the CQC system manager for all Definable Features of Work, as follows:

2.5.1 Preparatory Phase

This phase shall be performed prior to beginning work on each Definable Feature of Work and shall include:

- a. A review of each paragraph of applicable specifications.
- b. A review of the contract plans.
- c. A check to assure that materials and equipment have been tested, submitted, and approved.
- d. A check to assure that provisions have been made to provide required control inspection and testing.
- e. Examination of the work area to assure that required preliminary work has been completed and is in compliance with the contract.
- f. A physical examination of required materials, equipment, and sample work to assure that they are on hand, conform to approved shop drawing or submitted data, and are properly stored.
- g. A review of the appropriate activity hazard analysis, work control package(s), and procedure(s) to assure safety and quality requirements are met.
- h. Discussion of procedures for constructing the work including lessons learned. Document construction tolerances and workmanship standards for that phase of work.

- i. A check to ensure that the portion of the plan and suppliers for the work to be performed has been accepted by the CONTRACTOR.
- j. The CONTRACTOR shall be notified at least 24 hours in advance of beginning the preparatory phase. This phase shall include a meeting conducted by the CQC system manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The results of the preparatory phase actions shall be documented by separate minutes prepared by the CQC system manager and attached to the daily QC report. The SUBCONTRACTOR shall instruct and train applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

2.5.2 Initial Phase

This phase shall be accomplished at the beginning of a Definable Feature of Work. The following shall be accomplished:

- a. A check of preliminary work to ensure that it is in compliance with contract requirements. Review minutes of the preparatory meeting.
- b. Verification of full contract compliance. Verify required control inspection and testing.
- c. Establish level of workmanship, qualification, and training and verify that it meets minimum acceptable workmanship standards. Compare with sample panels if appropriate.
- d. Resolve differences.
- e. Check safety to include compliance with and upgrading of the safety plan, activity hazard analysis work control package(s), and procedure(s) to assure safety and quality. Review with each worker.
- f. The CONTRACTOR shall be notified at least 24 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the CQC system manager and attached to the daily QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
- g. The initial phase shall be repeated for each new crew to work on-site, or any time acceptable specified quality standards are not being met.

2.5.3 Follow-up Phase

Daily inspections shall be performed to assure continuing compliance with contract requirements, including control testing, until completion of the particular feature of work. The inspections shall be documented in accordance with the. Final follow-up inspections shall be

conducted and deficiencies corrected prior CQC to the start or completion of work that may be affected by the deficient work. The SUBCONTRACTOR shall not build upon or conceal non-conforming work.

2.5.4 Additional Preparatory and Initial Phases

Additional preparatory and initial phases shall be conducted on the same Definable Features of Work as determined by the CONTRACTOR if the quality of on-going work is unacceptable; or if there are changes in the applicable QC staff or in the on-site production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

2.6 TESTS

The SUBCONTRACTOR shall perform tests specified or required to verify that control measures are adequate to provide a product that conforms to contract requirements. Testing includes operation, in process, verification and acceptance tests when required/specified. Testing shall be performed in accordance with GC-32, TESTING, of the General Conditions. The SUBCONTRACTOR shall procure the services of a CONTRACTOR-approved testing laboratory or establish an approved testing laboratory at the project site. A list of tests to be performed shall be furnished as part of the CQC plan. The list shall give the test name, frequency, specification paragraph containing the test requirements, work implementing document (procedure, work package, etc.) quality control required for, the personnel and laboratory responsible for each type of test and estimate of the number of tests required. The SUBCONTRACTOR shall perform the following activities and record and provide the following data:

- a. Verify that testing procedures comply with contract requirements
- b. Verify that facilities and testing equipment are available and comply with testing standards
- c. Check test instrument calibration data against certified standards
- d. Verify that recording forms and test identification control number system, including the test documentation requirements, have been prepared.
- e. Results of tests taken, whether passing or failing, and retests, shall be recorded on the QC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test shall be recorded. Actual test reports may be submitted later, if approved by the CONTRACTOR, with a reference to the test number and date taken. An information copy of tests performed by an off-site or commercial test facility shall be provided directly to the CONTRACTOR. Failure to submit test reports, as stated, may result in nonpayment for related work performed, rework, and disapproval of the test facility for this contract.

2.6.1 Testing Laboratories

The CONTRACTOR reserves the right to check laboratory equipment in the proposed laboratory for compliance with the standards set forth in the contract specifications and to check the laboratory technician's testing procedures and techniques. Laboratories utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in American Society for Testing and Materials (ASTM) D3740 and E329. Laboratories used for geosynthetics shall be accredited by the Geosynthetics Accreditation Institute – Lab Accreditation Program (GAI-LAP) for each test procedure.

The CONTRACTOR reserves the right to utilize the SUBCONTRACTOR's control testing laboratory and equipment to make assurance tests and to check the SUBCONTRACTOR's testing procedures, techniques, and test results at no additional cost to the CONTRACTOR.

2.6.2 Furnishing or Transportation of Samples for Testing

Costs for the transportation of samples or materials shall be borne by the SUBCONTRACTOR. Samples of materials for test verification and acceptance testing by the CONTRACTOR shall be delivered to the CONTRACTOR's Representative.

2.7 COMPLETION INSPECTION

At the completion of work or any increment thereof established by a completion time stated in clause entitled COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (SC-9 of Exhibit B), or stated elsewhere in the specifications, the CQC system manager shall conduct an inspection of the work and develop a 'punch list' of items which do not conform to the approved plans and specifications. Such a list of deficiencies shall be included in the CQC documentation, as required by paragraph DOCUMENTATION below, and shall include the estimated date by which the deficiencies will be corrected. The CQC system manager or staff shall make a second inspection to ascertain that deficiencies have been corrected and so notify the CONTRACTOR. These inspections and any deficiency corrections required by this paragraph shall be accomplished within the time stated for completion of the entire work or any particular increment thereof if the project is divided into increments by separate completion dates.

2.8 DOCUMENTATION

The SUBCONTRACTOR shall maintain current records of QC operations, activities, and tests performed, including the work of subcontractors and suppliers. These records shall be on an acceptable form and shall include factual evidence that required QC activities and tests have been performed, including but not limited to the following:

- a. SUBCONTRACTOR and Suppliers and their area of responsibility.
- b. Operating plant/equipment with hours worked, idle, or down for repair.

- c. Test and control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, and Follow-up). List deficiencies noted along with corrective action.
- d. Off-site surveillance activities, including actions taken.
- e. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
- f. List instructions given/received and conflicts in plans and specifications.
- g. SUBCONTRACTOR's verification statement.
- h. Work performed today, giving location, description, and by whom.
- i. Material received with statement as to its acceptability and storage.
- j. Identify submittals reviewed, with contract reference, by whom, and action taken.

These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the CONTRACTOR daily by 8 a.m. the next work day. As a minimum, one report shall be prepared and submitted for every seven days of no work and on the last day of a no work period. Calendar days shall be accounted for throughout the life of the contract. The first report following a day of no work shall be for that day only. Reports shall be signed and dated by the CQC system manager. The report from the CQC system manager shall include copies of test reports and copies of reports prepared by subordinate QC personnel.

2.8.1 Survey

The SUBCONTRACTOR shall provide CQC survey of the trench liner components and related trench infrastructure including piping, roads and buildings. The SUBCONTRACTOR shall verify liner component thickness on a 50 foot grid and breaks in grade.

The CONTRACTOR will also require the CQA SUBCONTRACTOR to provide a trench liner survey to verify SUBCONTRACTOR's work. SUBCONTRACTOR shall provide CQA SUBCONTRACTOR 48 hours notice for mobilization for this survey.

2.9 NOTIFICATION OF NONCOMPLIANCE

The CONTRACTOR will notify the SUBCONTRACTOR of any detected noncompliance. The SUBCONTRACTOR shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the SUBCONTRACTOR at the site of the work, shall be deemed

sufficient for the purpose of notification. If the SUBCONTRACTOR fails or refuses to comply promptly, the CONTRACTOR may issue an order stopping the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the SUBCONTRACTOR.

2.10 CONSTRUCTION QUALITY ASSURANCE PLAN COMPLIANCE

The CONTRACTOR will contract with an independent construction quality assurance subcontractor (CQA SUBCONTRACTOR), who will utilize the CQAP to assure the following:

- Facility components are constructed in accordance with the plans and specifications.
- The requirements are documented sufficiently to demonstrate compliance with CONTRACTOR regulations.

SUBCONTRACTOR shall assist the CONTRACTOR'S independent CQA SUBCONTRACTOR by providing documentation, records, material, equipment, and labor as required to demonstrate that the facility construction is acceptable in accordance with the Technical Specifications. When tests or documentation activities are required to be performed by the independent CQA SUBCONTRACTOR, the SUBCONTRACTOR shall stop work on those areas until authorized to proceed. In the event material tests fail, the SUBCONTRACTOR shall bring the material into compliance with the plans and specifications and support additional testing as required.

2.11 MINIMUM TESTING REQUIREMENTS

All materials, products and components manufactured, procured or fabricated by SUBCONTRACTOR as part of the Work shall be subjected to such workmanship, tests, inspections, surveillance, supervision, and control as may be necessary to verify compliance with the requirements of the Subcontract Documents. This paragraph lists the minimum testing requirements for the major construction components. Additional quality control requirements for the Work are specified in other sections of the Subcontract. These additional specifications and standards are "in addition to" those specified in this paragraph. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in the applicable Specification for the feature of work.

Sitework (0600X-SP-C0072)

Phase	Material	Test and ASTM Number	Frequency
Pre-construction	Backfill		
	Waste Trench Subgrade	In-Place Density (D2922)	1 per 900 m ² (9,688 sf)
	Roadway Subgrade	In-Place Density (D2922)	1 per 60 m (197 ft) per lift
Construction	Building Subgrade	In-Place Density (D2922)	1 per 10 m ² (108 sf) per lift for fill and backfill
	Utility Systems Subgrade	In-Place Density (D2922)	1 per lift for every 100 m (328 ft) for fill and backfill
	Roadways-Base and Surface Materials	In-Place Density (D2922)	Two tests every 60 m (197 ft), one at centerline, and one at roadway shoulder
	Roadway Backfill	In-Place Density (D2922)	1 per 60 m (197 ft) per lift
	Fill and Backfills for Buildings	In-Place Density (D2922)	1 per 10 m ² (108 sf) per lift for fill and backfill
	Utility Systems-Trench Backfill and Final Backfill	In-Place Density (D2922)	1 per lift for every 100 m (328 ft) of installation
	General Fills	In-Place Density (D2922)	1 per 1860 m ² (19,620 sf) per lift
Termination Berms	In-Place Density (D2922)	1 per 100 m (328 ft)	
Riser Pipe Trench Backfill	In-Place Density (D2922)	1 per 30 m (100 ft) per lift	

Notes:

1. ASTM C136 shall be used when the amount of material passing the No. 200 sieve is less than 12% by weight. ASTM D422 shall be used when the fine soil fraction is greater than this value.

Admix Soil Liner (0600X-SP-C0067)

Phase	Material	Test and ASTM Number	Frequency
Pre-construction ⁽¹⁾	Bentonite	Manufacturer's Certificates	1 per 450 metric tons (500 tons) delivered
	Admix		
		Maximum Clod Size	Periodic Visual Monitoring
		Belt Scale Measurements	1 per 4,000 m ³ (5,232 cy)
	Base Soil		
Test Fill	Admix	Visual Observation	Continuous
		In-place Moisture-Density (Nuclear, D2922)	3 per lift
		In-Place Moisture-Density (Rubber Balloon, D2167) (Sand Cone, D1556)	1 per lift
Construction	Admix	In-Place Moisture-Density (Nuclear, D2922)	1 per 200 m ³ (262 cy)
		Rubber Balloon (D2167) or Sand Cone (D1556) Moisture-Density	1 per day, if nuclear gage is used.
			1 per 8000m ³ (10,464 cy)

(1) Trench subgrade testing referenced in 0600X-SP-C0072 table.

Gravel Drainage Layers (0600X-SP-C0069)

Phase	Material	Test and ASTM Number	Frequency
Pre-Construction	Borrow Source	Grain Size Distribution (C136)	1 per 4,000 m ³ (5,232 cy)
		Permeability (D2434)	1 per 4,000 m ³ (5,232 cy)
		Carbonate Content (D4373)	1 per 8,000 m ³ (10,464 cy)
		Slake Durability (D4644)	1 per 8,000 m ³ (10,464 cy)
Construction	Gravel, when delivered	Visual Observation	Continuous
		Grain Size Distribution (C136)	1 per 1,500 m ³ (1,962 cy)
		Permeability (D2434)	1 per 1,500 m ³ (1,962 cy)
		In Place Density (D2922) ⁽¹⁾	1 per 1,500m ³ (1,962cy)

(1) Type B material only.

Operations Layer (0600X-SP-C0069)

Phase	Material	Test and ASTM Number	Frequency
Pre-construction	Proposed Material		
Construction		Visual Observations	Continuous
		In-Place Density (D2922)	1 per 1,800 m ² (19,375 sf)

Anchor Trench/Side Slope Riser Pipe Trench (0600X-SP-C0068 and 0600X-SP-C0072)

Phase	Material	Test and ASTM Number	Frequency
Pre-Construction	Prior to backfilling	Visual Observation	Continuous
Construction ⁽¹⁾		Visual Observations	Periodic

(1) Density testing requirements provided above 0600X-SP-C0072 table.

HDPE Geomembrane (0600X-SP-C0068)

Phase	Material	Test and ASTM Number	Frequency
Pre-Shipment (Before Shipping)	Resin	Manufacturer's Documentation Certification and QC Test Results	Every Lot
	Geomembrane	Manufacturer's Documentation, Certification and QC Test Results	Every Roll
Pre-Construction (Before Installing) (Note 1)	Geomembrane	Receiving Inspection	Every Roll
		Friction Angle (Direct Shear – D5321) Textured HDPE Liner vs. Admix Liner	2 Tests Total
	Extrudate	Documentation and Certification	Every Resin Lot
	Installation Surface	Installer's Certification of a Suitable Installation Surface	Each Installation Surface
Construction	Geomembrane	Seam Overlap	Every Panel
		Trial Seams	Every 4 Hours per Welder per Machine
		Vacuum Test ASTM (D5641)	All Extrusion or Single Wedge Fusion Welds
		Air Pressure Test ASTM (D5820)	All Double Wedge Fusion Welds
		Seam Destructive Test (D6392) 5 Peel/5 Shear	Min. Avg. of 1 per 150 m (492 ft) per Welder

Geotextile (0600X-SP-C0068)

Phase	Material	Test and ASTM Number	Frequency
Pre-Shipment (Before Shipping)	Geotextile and Thread	Manufacturer's Documentation, Certification, and QC Test Results	Every 5,000 m ² (53,820 sf) per Lot
Pre-Construction (Before Installing) (Note 1)	Geotextile	Receiving Inspection	Every Roll

Geocomposite (0600X-SP-C0068)

Phase	Material	Test and ASTM Number	Frequency
Pre-Fabrication (Before Bonding Geotextile to Geonet)	Geonet and Geotextile Components	Manufacturer's Documentation, Certification and QC Tests	Every 5,000 m ² (53,820 sf) per Lot
		Passing Conformance Test Results for both the Geonet and the Geotextile	
Pre-Shipment (After Bonding, Before Shipping)	Geocomposite	Manufacturer's Documentation, Certification and QC Test Results	
Pre-Construction (Note 1)	Geocomposite	Receiving Inspection	Every Roll
		Friction Angle (Direct Shear - D5321) Geocomposite vs. Textured HDPE Liner	2 Tests Total
		Friction Angle (Direct Shear - D5321) Geocomposite vs. Operations Layer	2 Tests Total

Geonet (0600X-SP-C0068)

Phase	Material	Test and ASTM Number	Frequency
Pre-Shipment (Before Shipping)	Geonet	Manufacturer's Documentation Certification and QC Tests	Every 5,000 m ² (53,820 sf) per lot
Pre-Construction (Before Installing) (Note 1)	Geonet	Receiving Inspection	Every Roll

Notes:

1. Testing may be performed prior to shipment from factory or after delivery at site.

Reinforced Concrete minimum testing requirements are described in Specification No. 0600X-SP-C0070. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-C0070.

Crest Pad Building minimum testing requirements are described in Specification No. 0600X-SP-C0071. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-C0071.

Metals minimum testing requirements are described in Specification No. 0600X-SP-C0073. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-C0073.

Coatings and Finishes minimum testing requirements are described in Specification No. 0600X-SP-A0024. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-A0024.

Electrical Work minimum testing requirements are described in Specification No. 0600X-SP-E0024 and in section titled ACCEPTANCE TEST PROCEDURE below. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-E0024.

Pipes, Valves, and Specials minimum testing requirements are described in Specification No. 0600X-SP-M0029 and in section titled ACCEPTANCE TEST PROCEDURE below. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-M0029.

Leachate Pump minimum testing requirements are described in Specification No. 0600X-SP-M0030 and in section titled ACCEPTANCE TEST PROCEDURE below. The SUBCONTRACTOR shall maintain records of his quality control for operations as described in section titled CONSTRUCTION QUALITY CONTROL in Specification No. 0600X-SP-M0030.

2.12 ACCEPTANCE TEST PROCEDURE

An example Acceptance Test Procedure (ATP) is attached to this section. This ATP has been prepared to provide example field testing procedures to demonstrate that the Electrical/Instrumentation and Piping/Mechanical systems for the Disposal Trench and Support Facilities function as intended by the design. The SUBCONTRACTOR shall provide an ATP for CONTRACTOR approval then perform the ATP under the coordination of the CONTRACTOR-designated Test Director.

SUBCONTRACTOR shall review the completed ATPs from previous ERDF cell construction projects and incorporate applicable revisions in the SUBCONTRACTOR's ATP. SUBCONTRACTOR shall perform a verification ATP prior to the final ATP performed under

the coordination of the CONTRACTOR-designated Test Director to ensure the systems perform in accordance with specified requirements. SUBCONTRACTOR shall supply all test equipment.

2.13 HOLD POINTS

Mandatory hold points will be established for certain key activities as identified in the following table. At these points, the SUBCONTRACTOR shall cease work on the affected activity until it has been reviewed by the CONTRACTOR and/or CQA Subcontractor. The schedule for hold points will be determined in the SUBCONTRACTOR's procurement and construction schedule for the project. SUBCONTRACTOR will update these schedules weekly and provide the CONTRACTOR and CQA Subcontractor at least one week notice prior to a hold point inspection. The CQA hold point schedules will be updated and presented provided to the CONTRACTOR on a weekly basis. Additional hold points shall be identified in the SUBCONTRACTOR's CQC Plan for work features not identified as a CQA Hold Point.

CQA HOLD POINTS

Phase	Activity	Hold Point	Proceed to Next Activity
Excavation	Surface	Before Covering Subject Portion with Next Layer	Passing results for density tests
			CQA review of subcontractor and CQA surveys
Soil Liner	Admix Placement	Before Placing in Cell	Passing test results for test fill and stockpiled admix
	Individual Lift or Final Surface	Before Covering Subject Portion with Next Layer	Passing results for all CQA tests CQA review of subcontractor and CQA surveys
HDPE Liner	Delivery	Before Shipping	Manufacturer's Documentation
			Acceptable Friction Angle test results vs. admix and geocomposite
	Installation	Before Installing	Passing conformance test results
		Before Covering Subject Portion with Next Layer	Installation records (CQA) review
			Visual inspection
Seam survey data			
Geotextile	Delivery	Before Shipping	Manufacturer's Documentation
	Installation	Before Installing	Passing conformance test results
		Before covering subject Portion with Next Layer	Visual Inspection Installation Records (CQA) Review
Geocomposite	Fabrication	Before Fabrication	Passing conformance test results for geotextile
			Passing conformance test results for geonet
	Delivery	Before Shipping	Manufacturer's Documentation
			Acceptable Friction Angle test results vs. HDPE liner and Operations Layer material.
Installation	Before Installing	Passing conformance test results	
	Before Covering Subject Portion with Next Layer	Visual Inspection Installation Records (CQA) Review	
Drainage Gravel	Delivery	Before Shipping	Passing Pre-construction test results
	Installation	Before Covering subject Portion with Next Layer	Passing CQA test results CQA review of subcontractor and CQA surveys
Operations Layer	Installation	Before Installing	Passing CQA test results
		After Installing	CQA review of subcontractor and CQA surveys
Piping	Installation	Before Backfilling Trenches	Passing Pressure and Leak Test Results

APPENDIX A
EXAMPLE ACCEPTANCE TEST PROCEDURES

**PROJECT
ENVIRONMENTAL RESTORATION
DISPOSAL FACILITY CELLS 7 and 8**

**HANFORD SITE
RICHLAND, WASHINGTON**

**EXAMPLE
ACCEPTANCE TEST PROCEDURES**

Date

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ACCEPTANCE TEST PROCEDURE

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY

1.0 PURPOSE OF THE ACCEPTANCE TEST

This acceptance test procedure (ATP) has been prepared to establish field testing procedures to demonstrate that the Electrical/Instrumentation and Piping/Mechanical systems for the Disposal Trench and Support Facilities function as intended by the design.

2.0 REFERENCE DRAWINGS AND SPECIFICATIONS

2.1 DRAWINGS

<u>Drawing Number</u>	<u>Drawing Title</u>
0600X-DD-G0026	Title, Location & Hanford Area Maps
0600X-DD-G0027	Drawing List
0600X-DD-G0028	Symbols
0600X-DD-G0029	Abbreviations
0600X-DD-C0258	Overall Site Plan
0600X-DD-C0259	Construction Limits and Fence Location - Cells 7 & 8
0600X-DD-C0260	Construction Limits and Fence Location - Cells 9 & 10
0600X-DD-C0261	Coordinate Table
0600X-DD-C0262	Fence Details
0600X-DD-C0263	Sign Details
0600X-DD-C0264	Reserve for Future Use
0600X-DD-C0265	Existing Topography
0600X-DD-C0266	Project Office Trailer Placement
0600X-DD-C0267	Subgrade & Cell Berm Contours – Cells 7 & 8
0600X-DD-C0268	Subgrade & Cell Berm Contours – Cells 9 & 10
0600X-DD-C0269	Subgrade Survey Control – Cells 7 & 8
0600X-DD-C0270	Subgrade Survey Control – Cells 9 & 10
0600X-DD-C0271	Admix Layer Contours – Cells 7 & 8
0600X-DD-C0272	Admix Layer Contours – Cells 9 & 10
0600X-DD-C0273	Secondary Drainage Layer Contours – Cells 7 & 8
0600X-DD-C0274	Secondary Drainage Layer Contours – Cells 9 & 10
0600X-DD-C0275	Primary Drainage Layer Contours – Cells 7 & 8
0600X-DD-C0276	Primary Drainage Layer Contours – Cells 9 & 10
0600X-DD-C0277	Operations Layer Contours – Cells 7 & 8
0600X-DD-C0278	Operations Layer Contours – Cells 9 & 10
0600X-DD-C0279	Civil Sections

<u>Drawing Number</u>	<u>Drawing Title</u>
0600X-DD-C0280	General Cross Sections
0600X-DD-C0281	Liner System Details – 1
0600X-DD-C0282	Liner System Details – 2
0600X-DD-C0283	Liner Termination Details - 1
0600X-DD-C0284	Liner Termination Details- 2
0600X-DD-C0285	Sump Layout Plan - Cell 7
0600X-DD-C0286	Sump Layout Plan - Cell 8
0600X-DD-C0287	Sump Layout Plan - Cell 9
0600X-DD-C0288	Sump Layout Plan - Cell 10
0600X-DD-C0289	Sump Details – 1
0600X-DD-C0290	Sump Details – 2
0600X-DD-C0291	In-Cell Leachate Piping Plan – Cells 7 & 8
0600X-DD-C0292	In-Cell Leachate Piping Plan – Cells 9 & 10
0600X-DD-C0293	Crest Pad Plan and Elevation
0600X-DD-C0294	Yard Piping Plan – Cells 7 & 8
0600X-DD-C0295	Yard Piping Plan – Cells 9 & 10
0600X-DD-C0296	Reserve for Details
0600X-DD-C0297	Stockpile Plan – Cells 7 & 8
0600X-DD-C0298	Stockpile Plan - Cells 9 & 10
0600X-DD-C0299	Vadose Zone Monitoring System
0600X-DD-C0300	Vadose Zone Monitoring System Details
0600X-DD-C0301	Access Road Plan and Profile
0600X-DD-C0302	Access Road Plan and Profile
0600X-DD-C0303	Reserve for Future Details
0600X-DD-C0304	Access Road Details
0600X-DD-C0305	Reserve for Future Details
0600X-DD-C0306	Reserve for Future Details
0600X-DD-C0307	Reserve for Future Details
0600X-DD-C0308	Test Pits and Boring Locations
0600X-DD-C0309	Soil Boring Logs 1
0600X-DD-C0310	Soil Boring Logs 2
0600X-DD-C0311	Soil Boring Logs 3
0600X-DD-C0312	Soil Test Pit Logs 1
0600X-DD-C0313	Soil Test Pit Logs 2
0600X-DD-C0314	Reserve for Future Details
0600X-DD-C0315	Soil Test Pit Logs -3
0600X-DD-C0316	Crest Pad Bldg Structural Plans and Sections
0600X-DD-C0317	Structural Details – 1
0600X-DD-C0318	Structural Details – 2
0600X-DD-C0319	Reserve for Future Details
0600X-DD-A0014	Crest Pad Bldg – Plans and Elevations
0600X-DD-A0015	Architectural Details – 1

<u>Drawing Number</u>	<u>Drawing Title</u>
0600X-DD-A0016	Architectural Details – 2
0600X-DD-A0017	Finish Schedules
0600X-DD-E0104	Electrical Symbols
0600X-DD-E0105	Electrical Abbreviations and General Notes
0600X-DD-E0106	Electrical Details – 1
0600X-DD-E0107	Electrical Details – 2
0600X-DD-E0108	Reserve for Future Details
0600X-DD-E0109	Electrical Cable and Raceway Schedule
0600X-DD-E00110	Electrical Cable and Raceway Schedule
0600X-DD-E00111	Electrical Site Plan – Cells 7 & 8
0600X-DD-E00112	Electrical Site Plan – Cells 9 & 10
0600X-DD-E00113	Electrical One-Line Switchgear
0600X-DD-E00114	MCC One-Line Diagrams
0600X-DD-E00115	Reserved for Future Details
0600X-DD-E00116	MCC Details
0600X-DD-E00117	Electrical Schedules
0600X-DD-E00118	Control Schematics – 1
0600X-DD-E00119	Control Schematics – 2
0600X-DD-E00120	Control Schematics – 3
0600X-DD-E00121	Control Schematics – 4
0600X-DD-E00122	Control Schematics – 5
0600X-DD-E00123	Crest Pad Electrical Power Plan
0600X-DD-E00124	Crest Pad Electrical Lighting Plan
0600X-DD-M0022	Piping Details
0600X-DD-M0023	Mechanical Schedules
0600X-DD-M0024	Mechanical Details – 1
0600X-DD-M0025	Mechanical Schedules
0600X-DD-M0026	Reserve for Future Details
0600X-DD-M0027	Crest Pad Details – 1
0600X-DD-M0028	Crest Pad Details – 2
0600X-DD-M0029	Reserve for Future Details

2.2 SPECIFICATIONS

<u>Specification Number</u>	<u>Specification Title</u>
0600X-SP-G0037	Quality Control Requirements
0600X-SP-G0038	Supplier Quality Assurance Requirements
0600X-SP-A0024	Coatings & Finishes
0600X-SP-C0067	Cell Construction- Admix Layer
0600X-SP-C0068	Cell Construction- Geosynthetics
0600X-SP-C0069	Cell Construction- Leachate Collection Systems and Lysimeters
0600X-SP-C0070	Reinforced Concrete
0600X-SP-C0071	Crest Pad Building
0600X-SP-C0072	Site Work
0600X-SP-C0073	Metals
0600X-SP-E0024	Electrical Work
0600X-SP-M0029	Pipe, Valves & Specials
0600X-SP-M0030	Leachate Pumps

3.0 RESPONSIBILITIES

Each company or organization participating in the conduct of this ATP will designate personnel to assume the responsibilities and duties as defined herein for their respective roles. The names of these designees shall be provided to the Recorder for listing on the Recorder's copy of the Test Execution Sheet prior to the performance of any part of this ATP.

3.1 (CONTRACTOR) WASHINGTON CLOSURE HANFORD (WCH)

- 3.1.1 Designate a Test Director.
- 3.1.2 Act as liaison between the participants in acceptance testing.
- 3.1.3 Establish and distribute the testing schedule.
- 3.1.4 Schedule and conduct a pre-ATP meeting with test participants prior to start of testing.
- 3.1.5 Notify all persons performing and witnessing the test prior to the start of testing.
- 3.1.6 Notify all concerned parties when a change is made in the testing schedule.
- 3.1.7 Sign Test Execution Sheet when ATP is approved and accepted.

- 3.1.8 Take necessary action to clear exceptions to the ATP.
- 3.1.9 Sign Exception Sheet when exception has been resolved.
- 3.1.10 Provide a distribution list for the approved and accepted ATP.

3.2 TEST DIRECTOR

- 3.2.1 Coordinate acceptance testing.
- 3.2.2 Distribute documents including completed ATP, exceptions, resolutions and approvals.
- 3.2.3 Confirm that field testing and inspection of the system or portion of the system to be tested has been completed.
- 3.2.4 Stop any test which, in the judgment of the Director, may cause damage to the system until the test procedure has been revised.
- 3.2.5 Obtain revisions to the ATP, as necessary, to comply with authorized field changes or to accommodate existing field conditions.
- 3.2.6 Evaluate recorded data, discrepancies, and exceptions.
- 3.2.7 Obtain from the CONTRACTOR any information related to this ATP or changes necessary to clear or resolve objections.
- 3.2.8 Sign Test Execution Sheet when ATP has been completed.
- 3.2.9 Sign Exception Sheet when retest has been executed and accepted.

3.3 WITNESSES

Witnesses shall be provided as directed by the CONTRACTOR.

- 3.3.1 Witness the tests.
- 3.3.2 Evaluate results of testing.
- 3.3.3 Assist the Test Director when requested.
- 3.3.4 Sign Test Execution Sheet as a Witness.
- 3.3.5 Sign Exception Sheet as a Witness when retest has been executed and accepted.

3.4 RECORDER

The Recorder will be provided by the WCH subcontracted Quality Assurance Engineer.

- 3.4.1 Prepare Test Data Forms to record ATP data and observations.
- 3.4.2 Record names of all designated personnel on Recorder's copy of ATP prior to start of testing.
- 3.4.3 Observe tests and record test data.
- 3.4.4 Sign the Test Execution Sheet as the Recorder.
- 3.4.5 On the Exception Sheet, record objections or exceptions and test activities which are not performed.
- 3.4.6 Orally notify the Test Director at the time an objection is made.
- 3.4.7 Assign page numbers to all test data sheets and Exception Sheets, after ATP is complete. Submit the completed ATP documents to the CONTRACTOR.

3.5 CONSTRUCTION SUBCONTRACTOR

- 3.5.1 Organize and perform this acceptance test under coordination of the Test Director.
- 3.5.2 Confirm that all equipment required for performing this test will be available at the start of testing.
- 3.5.3 Provide equipment required for performing this acceptance test, unless designated by these procedures as being supplied by others.
- 3.5.4 Provide lock and tag materials and personnel to perform ATP.
- 3.5.5 Request in writing from the CONTRACTOR those services, materials, or equipment that have been designated as being supplied by the CONTRACTOR or others.
- 3.5.6 Sign the Test Execution Sheet when the ATP has been completed.
- 3.5.7 Sign the Exception Sheet when the retest has been completed and accepted.

3.6 OCCUPATIONAL SAFETY AND HEALTH

Individuals shall carry out their assigned work in a safe manner to protect themselves and others from undue hazards and to prevent damage to property and environment. Performance of test activities shall always include safety and health aspects as delineated in the most current version

of the Federal Occupational Safety and Health Administration/Washington Industrial Safety and Health Act (OSHA/WISHA) safety health codes and standards.

4.0 ACCEPTANCE TEST PROCEDURE CHANGE CONTROL

Acceptance testing shall be conducted in accordance with the steps and requirements specified in this procedure. Any required changes must be authorized in accordance with approved change control procedures for this project and promptly accomplished. Procedure changes during testing must be approved by the CONTRACTOR, quality assurance, and the subcontracted quality assurance engineer (via initials). The recorder shall note these changes as exceptions (see Section 5.2), provided that these changes do not affect safety and health. The changes shall be noted in the final acceptance test report.

5.0 RECORDING AND RESOLVING EXCEPTIONS

5.1 GENERAL

Exceptions to the ATP are sequentially numbered and recorded on individual Exception Sheets. This enables case-by-case resolution, recording, approval, and distribution of each exception.

5.2 RECORDING

- 5.2.1 Number each exception sequentially as it occurs and record it on an Exception Sheet.
- 5.2.2 Enter name and organization of objecting party for each exception.
- 5.2.3 Describe the exception.
- 5.2.4 Record the action taken to resolve each exception. Include test results as applicable. Repeat the process as necessary until exception has been resolved.
- 5.2.5 When action taken results in an acceptable retest, sign and date the Exception Sheet.

6.0 TEST CONDITIONS AND EQUIPMENT REQUIRED

6.1 GENERAL

The following conditions shall exist at the start of the acceptance testing for that portion of the system being tested.

- 6.1.1 Systems being tested have been inspected for workmanship and for compliance with design.
- 6.1.2 Continuity tests have been performed on portions of the electrical system being tested.

- 6.1.3 Power is available to components of systems being tested.
- 6.1.4 Continuity tests of instrumentation wiring have been performed in accordance with the latest revision of the construction Specifications.
- 6.1.5 All test instruments have a valid calibration stamp attached that indicates a calibration traceable to the National Institute of Standards and Technology.
- 6.1.6 Personnel responsible for directing, witnessing and performing the tests described in this ATP are familiar with the equipment to be tested, have reviewed the vendor information pertaining to the operation of the equipment, and are familiar with the requirements of this acceptance test procedure.
- 6.1.7 Values used to simulate process inputs (such as water levels D1, D2, D3, D4, etc. - See Figure 1) and alarm conditions for execution of ATP have been provided.

6.2 EQUIPMENT REQUIRED

The Construction SUBCONTRACTOR shall supply all test equipment unless otherwise noted. Test equipment shall include electrical equipment, pressure gages, tapes or rods, and other measuring apparatus to perform the acceptance tests. Test equipment shall have suitable range and accuracy for the parameter being measured. All ancillary equipment such as jumpers, valves, piping, and similar items shall also be provided by the Construction SUBCONTRACTOR. All test equipment shall be approved by the Test Director prior to use.

7.0 TRANSDUCERS AND METER/CONTROLLERS IN LANDFILL SUMPS

This procedure will demonstrate the correct functioning of the level transducers and the associated meter/controllers. See Figure 1 for definitions of water levels and associated pumps and relays. Verify that the level transducers have been calibrated prior to installation.

7.1 PRIMARY

- 7.1.1 Pump the primary sump to below the low water level D1, Remove power to the pump in the sumps by opening the associated circuit breakers.
- 7.1.2 Verify that the relays associated with the high water levels (D2 and D4) in the primary sump are "off" (de-energized) and the relay associated with the low water levels (D1 and D3) in the primary sump are "on" (energized).
- 7.1.3 Verify pressure transducer out put in relation to foot of water head pressure. Provided table of output to feet of head.
- 7.1.3 Add water in increments as directed by the Test Director to primary sump via the secondary slope riser pipe. Record the volume of water added to the sump. Wait 2

minutes after each increment of water, and record the primary sump level meter reading. Verify that the primary sump level meter reading increases as water is added.

- 7.1.4 Continue adding water in increments and observe that the low water level relay is de-energized when the level is DS and that the high water level relay is energized when the level is DS Stop filling the sump.

8.0 LEACHATE PUMP TESTS

This procedure will demonstrate the correct functioning of the high capacity and low capacity leachate pumps and associated controls. See Figure 1 for definitions of water levels and associated pumps. For each of the leachate pumps, measure the phase currents prior to beginning pumping tests. Record this information on the top of the appropriate test data forms. Verify that motor overload devices are sized correctly.

8.1 INITIAL CONDITIONS FOR PUMP TESTS

Prior to testing pumps, verify that the relay associated with the high water levels for the leachate storage tanks is de-energized, that the valves in the manholes for the leachate piping system are open, and that any water in the manholes is below the flood switches.

8.1.1 Primary Sump

This testing should begin with water in the primary sump above level D4. Verify the following conditions on the control panel:

- a. High water level relays are energized.
- b. Low water level relays are de-energized.
- c. Pump failure lights for the primary low capacity and high capacity submersible pumps are on.
- d. The roof alarm light is on.
- e. The panel lights associated with the high water relays are on, and the panel lights associated with the low water relays are off.

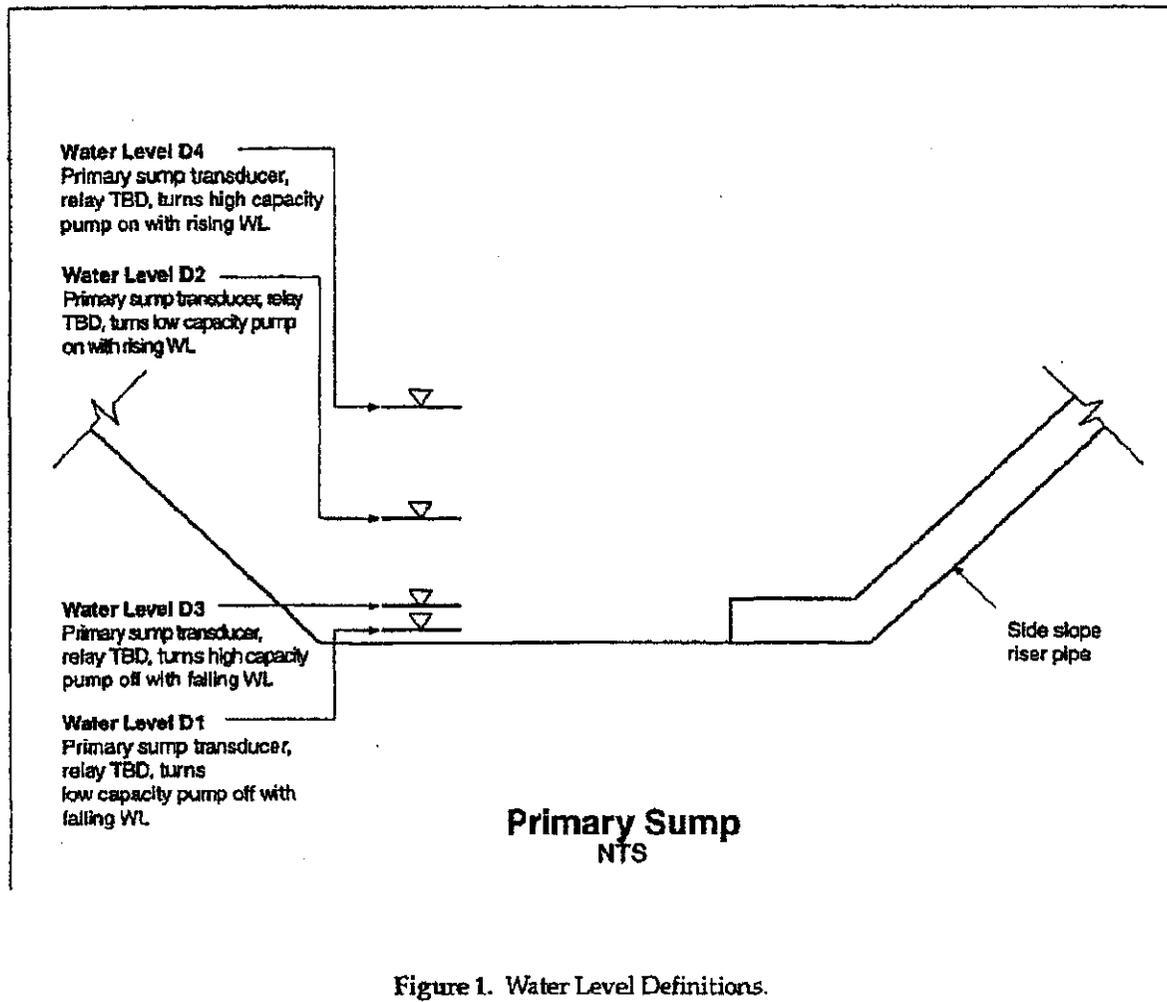


Figure 1. Water Level Definitions.

8.2 PRIMARY LEACHATE PUMPS

- 8.2.1 The switches on the control panel for the pumps should be in the "off" position.
- 8.2.2 Turn the switch for the low capacity pump to the "hand" position. Verify by observation (sight, sound, pipe vibrations, and/or transducer readings) that water is being pumped from the sump, and verify that the associated "pump run" light is on.
- 8.2.3 Turn the switch for the high capacity pump to the "hand" position. Verify by observation (sight, sound, pipe vibrations, and/or transducer readings) that water is being pumped from the sump, and verify that the associated "pump run" light is on.
- 8.2.4 Run the primary leachate pumps until the primary sump is drained below high water level D2.

- 8.2.5 Turn the primary leachate pump switches on the motor controller to “automatic” position. Add water to primary sump until the water reaches level D2.
- 8.2.6 Verify that the low capacity pump starts automatically and that the pump run light is on. Verify by observation that water is being pumped from the sump. Allow the pump to continue running in the “automatic” mode.
- 8.2.7 Resume or continue adding water to the primary sump until the water reaches the high capacity pump high water level (D4).
- 8.2.8 Verify that the high capacity pump starts automatically and that the pump run light is on. Verify by observation that water is being pumped from the sump.
- 8.2.9 Continue pumping both the high capacity and low capacity pumps in the automatic mode.
- 8.2.10 While the pumps are running, connect across the high-tank switch electrical terminals using a jumper, to simulate high water level in the storage tanks. Verify that the pumps are automatically stopped and that the roof alarm is initiated. Remove the jumper and re-initiate the automatic operation.
- 8.2.11 Verify that when the water level in the sump reaches low levels (water levels D1 and D3), the appropriate relays are energized, and both primary sump pumps are automatically shut off.

9.0 LEACHATE STORAGE AND TRANSFER SYSTEM

9.1 MANHOLE FLOOD ALARM SWITCHES

Demonstrate that when activated, each alarm switch will close the appropriate motor-operated valves in the manholes and will shut-off the pumps in the landfill.

9.2 FLOOD SWITCH

Demonstrate that when activated, each flood switch will close the appropriate motor-operated valve.

10.0 TEST EXECUTION SHEET

TEST EXECUTION SHEET

TEST NO. _____

ITEM _____

NUMBER OF EXCEPTIONS (ATTACH) _____

SUMMARY OF EXEPTIONS, ACTIONS TAKEN, AND RESULTS: _____

APPROVED:

FDPM Date

Test Director Date

Witness Name / Organization Date

Witness Name / Organization Date

Construction Subcontractor / Organization Date

Other / Organization Date

Recorder / Organization Date

11.0 EXCEPTION SHEET

EXCEPTION SHEET

EXCEPTION NUMBER. _____ SHEET _____ OF _____

DATE _____

EXCEPTIONS BY:

NAME

ORGANIZATION

DESCRIPTION: _____

ACTION TAKEN: _____

APPROVED:

FDPM Date

Test Director Date

Witness Name / Organization Date

Witness Name / Organization Date

Construction Subcontractor / Organization Date

Other / Organization Date

Recorder / Organization Date

**TECHNICAL SPECIFICATION
FOR
SUPPLIER QUALITY ASSURANCE PROGRAM REQUIREMENTS FOR
ERDF CELLS 7 THROUGH 10**

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**TECHNICAL SPECIFICATION
FOR
SUPPLIER QUALITY ASSURANCE PROGRAM REQUIREMENTS FOR
ERDF CELLS 7 THROUGH 10**

1.0 SUMMARY

- 1.1 This specification establishes the Quality Assurance Program requirements for Suppliers of items or services utilized by the SUBCONTRACTOR.
- 1.2 This specification does not delete or revise (but is in addition to) those requirements defined by the Subcontract documents. If the SUBCONTRACTOR identifies an inconsistency between this specification, the Subcontract documents, and codes and standards, the SUBCONTRACTOR shall immediately notify the CONTRACTOR in writing requesting resolution.

2.0 GENERAL PROGRAM REQUIREMENTS

- 2.1 The term Supplier, as used herein, includes Bidder, Seller, Vendor, and Subcontractor (sub tier subcontractors to the SUBCONTRACTOR), who provide services, materials, equipment, etc.
- 2.2 The Supplier shall establish, implement, and maintain a Quality Assurance Program (QAP) that conforms to the requirements specified on the Supplier Quality Assurance Program Requirements Data Sheet, and to the other applicable codes and standards as cited in Exhibit "E," Technical Specifications. These Quality Assurance requirements shall apply to work performed under this subcontract, including design, procurement, excavation and material handling, installation, inspection and testing. A QAP that is compliant with the attached data sheet is compliant with DOE Order 414.1C and 10CFR830, Subpart A. The governing requirements will be identified by the CONTRACTOR.
- 2.3 The QAP shall include the SUBCONTRACTOR's checking and approval process for submittals, record generation, data collection, inspections, and other documentation.
- 2.4 The SUBCONTRACTOR shall ensure that the Supplier submits proposed changes to the accepted QA program to CONTRACTOR for review prior to implementation.
- 2.5 The SUBCONTRACTOR's Project QA Representative (PQAR) shall be identified.

3.0 ADDITIONAL REQUIREMENTS

- 3.1 During the SUBCONTRACTOR's bid process for any activities relating to the performance of Subcontract scope the Supplier shall submit a copy of their QAP Document(s), which defines the program they will follow to meet this specification. With the document(s), the Supplier shall submit a Data Sheet (Attachment 1), which satisfies the criteria imposed.

For items covered entirely by the American Society of Mechanical Engineers (ASME) B&PV Code, Section III, the Supplier, if in possession of the appropriate Certificate of Authorization or Quality System Certificate (Materials) issued by ASME, need not submit the QAP, but provide a current copy of its Certificate.

The CONTRACTOR will evaluate, accept, or accept with comments, the Supplier's Quality Assurance Program document(s) if different from the SUBCONTRACTOR QA Program unless advised otherwise by CONTRACTOR. The CONTRACTOR may also require that a survey be performed to ensure that the Supplier's QA Program has been implemented and is acceptable. The Supplier may proceed only with those activities related to the QA Program elements that are acceptable, and authorization to proceed with additional activities will be granted only after acceptable changes to its QA documents have been agreed to and implemented by the Supplier. Changes must be submitted to the CONTRACTOR for final acceptance.

If the Supplier's function is limited to placing the order with the actual manufacturer, the Supplier shall be responsible for providing a controlled copy of the manufacturer's Quality Assurance Program Manual to the SUBCONTRACTOR and the SUBCONTRACTOR shall submit this to the CONTRACTOR. The manual must meet the requirements outlined in this specification. If the Supplier will store, repackage, or in any way handle the items before shipment to the SUBCONTRACTOR, the Supplier shall submit its QA Program manual in addition to the manufacturer's program manual. The manufacturer's and Supplier's Quality Assurance Program documents must meet the requirements, as outlined in this specification, that pertain to the work each organization performs.

- 3.2 Acceptance of a Supplier's QA Program by the CONTRACTOR does not relieve the SUBCONTRACTOR and Supplier of the obligation to comply with the requirements of the Subcontract documents, including this specification. If the quality program(s) is (are) subsequently found to be ineffective or inadequate in providing for acceptable control, the CONTRACTOR reserves the right to require necessary revisions. QA Program modifications shall be submitted to the CONTRACTOR for review and acceptance.
- 3.3 The SUBCONTRACTOR and Supplier shall identify and document conditions that do not meet the requirements of Subcontract document(s) or CONTRACTOR-accepted submittals. Those deviations, along with the SUBCONTRACTOR or Supplier's suggested corrective action, shall be transmitted to the CONTRACTOR on the Supplier Deviation Disposition Request (SDDR) Form (attached) for review and disposition. Deviations are considered unacceptable until approved by the CONTRACTOR in writing. Detailed instructions are provided on the back of the SDDR Form.

The SUBCONTRACTOR or Supplier shall submit the SDDR, including supporting technically valid information for evaluation, to the CONTRACTOR within five (5) working days after detection of the nonconforming condition. If this time limit cannot be met, the SUBCONTRACTOR or Supplier shall notify the CONTRACTOR through telephone, fax, or other appropriate means, and a revised submittal date shall be

established. Any SDDR prepared by lower tier Suppliers shall be submitted through the Supplier to the SUBCONTRACTOR and the SUBCONTRACTOR shall submit SDDR(s) to the CONTRACTOR. The CONTRACTOR will complete action on the SDDR and return a copy to the SUBCONTRACTOR. SUBCONTRACTOR is responsible to return the SDDR to the Supplier(s). Where indicated, the Supplier or SUBCONTRACTOR shall revise the documents to reflect the changed condition.

A copy of the approved SDDR (including attachments) shall be included by the Supplier in the Quality Verification data package for the affected item(s).

- 3.4 Engineering and quality verification documents shall be submitted to the CONTRACTOR in accordance with the provisions of the Supplier Submittal Requirements Summary (SSRS) form. Quality-related records, procedures, and qualifications shall be available for examination by the CONTRACTOR, CONTRACTOR's authorized agent, or Owner. No quality-related records shall be destroyed or otherwise disposed without the written permission of the CONTRACTOR until items required by the Subcontract documents have been delivered and final payment has been received by the Supplier. The Seller may be required to retain, for a limited time, certain records that are not transmitted to the CONTRACTOR. Record identification and retention time for these records, if required, will be covered by the Subcontract documents.
- 3.5 The CONTRACTOR has determined that, in general, flow down of Supplier's QAP requirements to lower tier suppliers of equipment and materials (such as casings, lubricants, etc.) is not required. A graded approach shall be employed in which the Supplier shall procure commercially available items and perform documented receipt inspection in accordance with the Supplier's approved QAP. Employing this graded approach, as allowed by both 10 CFR 830, Subpart A and DOE Order 414.1C, provides adequate assurance of quality commensurate with the hazards and other considerations. Should the circumstances be different for a specific piece of equipment or material, the CONTRACTOR will identify any necessary additional requirements. This provision does not apply to lower tier suppliers of services, in which case flow down of Supplier's QAP requirements is required.

4.0 QUALITY ASSURANCE

- 4.1 Designing, procuring, manufacturing, processing, assembling, testing, examination, inspection, documentation, and operations performed by the SUBCONTRACTOR's Supplier(s) and their lower tier Suppliers are subject to surveillance by the, SUBCONTRACTOR, CONTRACTOR, CONTRACTOR's authorized agent, or Owner. This surveillance shall in no way relieve the Supplier of any contractual responsibilities.

NOTE: The term "surveillance," as used here, may include inspection, survey, and assessment.

- 4.2 The CONTRACTOR, Owner, or their designee(s) shall be given free access to the

SUBCONTRACTOR's Supplier(s) and lower tier Supplier's facilities to perform surveillance on work during design, manufacturing, testing, documentation review, and shipping.

- 4.3 The SUBCONTRACTOR's Supplier(s) shall give the CONTRACTOR at least five (5) working days prior notice prior to performing tests and other check points in the manufacturing process specifically requested by the CONTRACTOR, after a joint review of the Supplier's work plan(s) and the Subcontract documents.
- 4.4 If the requirements of this specification have not been fulfilled by the SUBCONTRACTOR or Supplier, the CONTRACTOR has the authority to refuse to "release for shipment."

Attachment 1

**SUPPLIER QUALITY ASSURANCE
PROGRAM REQUIREMENTS DATA SHEET**

WCH QA&S Approval:

Quality Services Engineer Date

Quality Assurance Engineer Date

**WCH Engineering Services
Concurrence:**

_____ Date

SUPPLIER RESPONSE:

The quality assurance program (QAP) elements indicated below apply to this procurement and are subject to WCH evaluation and verification. Suppliers are responsible for noting below where the indicated QAP program elements are implemented in their QAP program document(s). Suppliers are responsible for designating applicable quality requirements for any subcontracted work in their subcontract documents and for ensuring that subcontracted work meets the requirements specified. The information and signature required below shall be submitted by the Supplier with the bid/proposal package.

Supplier QA program document(s):

Title: _____ **Revision:** _____ **Date:** _____

Title: _____ **Revision:** _____ **Date:** _____

Program Elements

**Reference to Applicable Supplier Document
Sections/Paragraphs**

- I Quality Management Program _____
- II Quality Training & Qualification _____
- III Quality Improvement _____
- IV Documents and Quality Records _____
- V Work Processes _____
- VI Design _____
- VII Procurement _____
- VIII Inspections & Tests _____
- IX Management Assessment _____
- X Independent Assessment _____

NOTE: For explanation of program elements, see following page.

Other Requirements:

- DOE O414.1C (For work that does not have the potential for radiological harm) _____
- Title 10 Code of Federal Regulations (CFR) 830 Subpart A, "Quality Assurance" _____

Supplier Representative:

Signature

Title

Date

Program Element No.	Program Element Title	Program Element Text
I	Quality Management Program	A written Quality Assurance Program (QAP) shall be developed, implemented, and maintained. The QAP shall describe the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing and assessing the work. The QAP shall describe management processes, including planning, scheduling, and resource considerations.
II	Quality Training & Qualification	Personnel shall be trained and qualified to ensure that they are capable of performing their assigned work. Personnel shall be provided continuing training to ensure that job proficiency is maintained.
III	Quality Improvement	Processes to detect and prevent quality problems shall be established and implemented. Items, services, and processes that do not meet established requirements shall be identified, controlled, and corrected according to the importance of the problem and the work affected. Correction shall include identifying the causes of problems and working to prevent recurrence. Item characteristic, process implementation, and other quality-related information shall be reviewed and data analyzed to identify items, services, and processes needing improvement.
IV	Document & Quality Records	Documents shall be prepared, reviewed, approved, issued, used, and revised to prescribe processes, specify requirements, or establish design. Records shall be specified, prepared, reviewed, approved, and maintained.
V	Work Processes	Work shall be performed to established technical standards and administrative controls using approved instructions, procedures, or other appropriate means. Items shall be identified and controlled to ensure their proper use. Items shall be maintained to prevent their damage, loss, or deterioration. Equipment used for process monitoring or data collection shall be calibrated and maintained.
VI	Design	Items and processes shall be designed using sound engineering/scientific principles and appropriate standards. Design work, including changes, shall incorporate applicable requirements and design bases. Design Interfaces shall be identified and controlled. The adequacy of design products shall be verified or validated by individuals or groups other than those who performed the work. Verification and validation of work shall be completed before approval and implementation of the design. Documents shall describe controls to be implemented for computer software management that includes software development, documentation, testing, and configuration control.
VII	Procurement	Procured items and services shall meet established requirements and perform as specified. Prospective suppliers shall be evaluated and selected on the basis of specified criteria. Processes to ensure that approved suppliers continue to provide acceptable items and services shall be established and implemented.
VIII	Inspection & Tests	Inspection and testing of specified items, services and processes shall be conducted using established acceptance and performance criteria. Equipment used for inspections and tests shall be calibrated and maintained.
IX	Management Assessment	Managers shall assess their management processes. Problems that hinder the organization from achieving its objectives shall be identified and corrected.
X	Independent Assessment	Independent assessments shall be planned and conducted to measure item and service quality, to measure the adequacy of work performance, and to promote improvement. The group performing independent assessments shall have sufficient authority and freedom from the line to carry out its responsibilities. Persons conducting independent assessments shall be technically knowledgeable in the areas assessed.

Attachment 2

SUPPLIER DEVIATION DISPOSITION REQUEST

	FOR SUPPLIER USE		FOR WCH USE		
	Supplier SDDR No.	Date Submitted	Project	WCH SDDR No.	Date Received
			Job No.:		
COMPLETED BY SUPPLIER	1. Supplier Name		Address		City, State & Zip
	2. Supplier's Order No.	3. Supplier's Part No.	4. Supplier's Part Name	5. Deviation Detected (Date & Method)	6. All Previous SDDR (No.'s & Dates)
	7. WCH P.O. & Rev. No.	8. WCH MR No. (part, item, tag, etc.)	9. WCH Part Name	10. WCH PQAR Notified (Date & Method)	11. WCH Eng. Notified (Date/Method)
	12. Deviation Description (Attach extra sheets, photographs, sketches, etc., as necessary and identify quantity and serial No.'s as applicable).				
	13. Supplier's Proposed Disposition: Use As-Is <input type="checkbox"/> Repair <input type="checkbox"/> Modify WCH Requirement <input type="checkbox"/>				
	14. Cost Impact:		15. Schedule Impact:		
	16. Proposed Disposition and Technical (plus Cost/Schedule, if applicable). Justification: Attach extra sheets, sketches, etc., as necessary.				
	17. Associated Supplier Document Change(s):				
	18. Supplier's Authorized Representative:				
	Name: _____		Signature: _____		
Title: _____		Date: _____			
WCH	19. WCH Engineering Action:				
	<input type="checkbox"/> Accepted	Engineering Action	<input type="checkbox"/> Drawing Change (<input type="checkbox"/> WCH <input type="checkbox"/> Supplier)	<input type="checkbox"/> Licensing Document Change	
	<input type="checkbox"/> Rejected		<input type="checkbox"/> Spec/Req. Change (<input type="checkbox"/> WCH <input type="checkbox"/> Supplier)	<input type="checkbox"/> Price Adjustment	
		Follow-Up	<input type="checkbox"/> Other Suppliers Affected	<input type="checkbox"/> Other	
	20. WCH Disposition Statement Including Justification (Attach extra sheets, sketches, etc., as necessary)				
21. WCH Disposition Approval/Signature					
FM: _____			Date: _____		
PE/SE: _____			Date: _____		
22. Supplier: _____			Date: _____		
23. WCH PQAR: _____			Date: _____		

WCH-DE-036 (09/01/2006)

INSTRUCTIONS FOR COMPLETING SDDR FORM

(Use Black Ink or Typewriter)

This form is to be used by a supplier to:

- (a) Notify CONTRACTOR when manufactured product or service does not meet established contract requirements and to document the supplier's proposed disposition, with their technical (and where appropriate, Cost/Schedule) justification
- (b) Notify CONTRACTOR when the supplier wants to propose changes to the contract documents unanticipated at time of award
- (c) Record CONTRACTOR's disposition of the SDDR.

A deviation is any departure from the requirements of the subcontract documents, which the supplier has incorporated or proposes to incorporate in the completed item or service provided. Deviation disposition can be classified as Use-As-Is, Repair, or Modify CONTRACTOR Requirement.

Repair is defined as the process of restoring a nonconforming characteristic to a condition such that the capability of an item to function reliably and safely is unimpaired, even though that item still may not conform to the original requirement. Repair includes alterations to the properties of the material through heat-treating, welding, metal deposition, chemical processing, etc. The SDDR form is not to be used for cases where CONTRACTOR has previously provided authorization to proceed using an accepted repair procedure covering a specific type of repair, however, records must be maintained for each specific repair.

CONTRACTOR's engineering action and disposition statement does not relieve the Supplier from responsibility for the accuracy, adequacy, or suitability of the item or service being provided as defined in the subcontract documents, nor does it constitute waiver of the right to renegotiate the terms of the subcontract documents.

Block no.

Entry Information

1. Supplier's name and address - city, state, and zip. List same information for lower-tier Suppliers if applicable.
2. Supplier's order number if one has been assigned.
3. Supplier's Part No.(s) as applicable from the drawing, catalog, internal specification, etc.
4. Supplier's Part Name.
5. Date deviation detected and method used to detect deviation (NDE, dimensional check, visual, etc.).
6. List all previous SDDRs (and their dates) that have been submitted for similar deviations requested on this Purchase Order.
7. CONTRACTOR Purchase Order Number and Revision Number.
8. CONTRACTOR Material Requisition (item, part, tag, or code) number(s).
9. CONTRACTOR Part Name, if one has been assigned.
10. Date and method (fax, letter, etc.) used to notify the CONTRACTOR Procurement Quality Assurance Representative (PQAR) whenever CONTRACTOR Quality Assurance is applicable.
11. Date and method (fax, letter, etc.) used to notify CONTRACTOR Engineering.
12. Describe the deviating characteristics and define the extent of the out-of-specification condition for each identified piece affected. Include quantities and serial, lot, batch, heat, or other numbers as appropriate. Identify the location of the deviating characteristic by printing coordinates or specific location, as applicable. Attach reproducible quality extra sheets, sketches, photographs, etc., as necessary. When proposing a change in either supplier or CONTRACTOR documents; describe the change; identify the documents completely including title or subject, date and revision; and where appropriate, attach a copy of areas in question.
13. State the proposed disposition.
14. Enter cost impact that would result from proposed changes and which will be reflected in appropriate Subcontract documents.
15. Enter delivery schedule impact that would result from proposed changes.
16. Describe the proposed disposition and provide technical (and where appropriate Cost/Schedule) justification for CONTRACTOR's evaluation. Attach reproducible quality copies whenever required. If the deviation is correctable by repair, submit a detailed repair procedure or reference the procedure previously submitted and assigned Level I by CONTRACTOR for use in similar situations. Provide CONTRACTOR control number, supplier control number, and procedure title. For documents, provide suggested corrective wording, procedures, documents, etc. Provide a copy of each SDDR attachment to the CONTRACTOR PQAR at the supplier's location, if applicable.
17. Identify the nature of changes that may be needed on associated supplier documents (drawings, specs., procedures, installation instructions, etc.).
18. Enter the name (typed or printed), and title of the supplier representative authorizing the disposition request and appropriate signature and date signed.
- *19. Check all applicable boxes to define the action required by CONTRACTOR Project Engineering. Note: Price adjustment requires Procurement Document (Purchase Order) Change.
- *20. Provide appropriate justification for the CONTRACTOR action(s) indicated in Block 19. When changes to drawings, specifications, requisitions, or other CONTRACTOR documents are involved, each document should be identified and the associated change briefly described. If other suppliers are affected, indicate who they are and the document that initiated resolution of that involvement. "Other" follow-up action (e.g., the need for additional CONTRACTOR calculations, additional drawings or sketches, inspection by a Project Engineering representative, etc.) should also be identified here. If Field Support action is required, indicate so.
- *21. GS - Signature of the responsible Group Supervisor (GS) accepting the Engineering action and the date signed. PE - Signature of the CONTRACTOR Project Engineer (or designee) and the date signed.
- Other position and signature(s) if required by project and date signed.
22. Signature of the supplier's inspector or other representative authorized to verify that the accepted disposition was correctly accomplished and the date signed.
- *23. Signature of the CONTRACTOR PQAR (when a CONTRACTOR PQAR is assigned to the order) and date. This signature indicates that the accepted disposition was correctly implemented and verified (on a random sample basis if the SDDR applies to several parts).

CONSTRUCTION EQUIPMENT

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CONSTRUCTION EQUIPMENT

1.0 GENERAL

1.1 SUMMARY

This specification establishes the general requirements for operating and maintaining construction and transportation equipment for the construction of ERDF cells 7 through 10.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meaning:

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CFR	U.S. Code of Federal Regulations
DOT	Department of Transportation
OSHA	Occupational Safety and Health Administration
RCW	Revised Code of Washington
SSRS	Subcontractor/Supplier Submittal Requirement Summary
WAC	Washington Administrative Code

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for operating and maintaining construction and transportation equipment. Failure of the SUBCONTRACTOR to identify any other applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 61	National Emissions Standards for Hazardous Air Pollutants
40 CFR 112	Oil Pollution Prevention
40 CFR 300	National Oil and Hazardous Substances Contingency Plan
49 CFR 393	Parts and Accessories Necessary for Safe Operation
ANSI/ASME	Applicable B30 Standards
RCW 46.37	Vehicle Lighting and Other Equipment
RCW 46.44	Size, Weight, Load
WAC 173 400	General Regulations for Air Pollution Sources

1.4 DEFINITIONS

Not used.

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor/Supplier Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.5.1 Equipment List

Before delivery, the SUBCONTRACTOR shall submit to the CONTRACTOR a listing of equipment that will be used during construction activities, a description of how such equipment will be used, and a description of any constraints or limitations associated with the equipment. The SUBCONTRACTOR shall update the equipment listing when additional equipment is brought on to or removed from the site. Prior to mobilization, the SUBCONTRACTOR shall submit certification that equipment delivered to the site is Occupational Safety and Health Administration (OSHA) compliant, uncontaminated, and has been inspected and meets the requirements of the Subcontract Documents.

The submittal shall include manufacturer's descriptive data, safety data, catalog cuts, literature and other data as necessary to fully describe that the proposed equipment comply with specified requirements.

1.5.2 Equipment Inspection and Preventive Maintenance Program

The SUBCONTRACTOR shall submit for approval an equipment inspection and preventive maintenance program. A checklist shall be developed for each piece of equipment that includes, at a minimum, items required by the manufacturer's recommendations, 29 CFR 1926.601 for motor vehicles and 29 CFR 1926.602 for material handling equipment. The checklist shall include or reference criteria for performing daily inspections. The checklist shall also include or reference criteria for determining the acceptability of equipment for use. Checklists are to ensure that safety-related devices (e.g., brakes, warning indicators, gages) are tested and functioning properly. The SUBCONTRACTOR's program shall include any hoisting and rigging techniques, methods, and equipment required for maintenance and repairs of the construction and transportation equipment.

The submittal shall include a description of the process for revising the checklists to ensure accuracy and adequacy prior to use.

1.5.3 Equipment Maintenance Pad

The SUBCONTRACTOR shall submit a proposed location for regular maintenance of the construction and transportation equipment. The location is subject to CONTRACTOR's approval. The submittal shall include any proposed grading, drainage and access, proposed fueling facilities and any other construction elements intended for equipment maintenance.

1.5.4 Material Safety Data Sheets

The SUBCONTRACTOR shall provide Material Safety Data Sheets for all fluids and other substances necessary for operating and maintaining construction and transportation equipment, in accordance with Exhibits "G" and "J".

2.0 MATERIALS AND EQUIPMENT

2.1 CONSTRUCTION EQUIPMENT

The SUBCONTRACTOR is responsible for selecting, procuring, delivering, operating and maintaining all construction equipment for the scope of work under this Contract. All equipment shall comply with the requirements listed in this Specification and any other requirements listed in other documents for this Contract. Equipment used on the project shall comply with Occupational Safety and Health Administration (OSHA) regulations 29 CFR 1910 and 29 CFR 1926 and the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B30 series of standards, as applicable.

The following restrictions shall apply:

1. The use of articulated dump trucks is prohibited;
2. The use of chains for any maintenance, equipment removal or any other purpose is prohibited.

The SUBCONTRACTOR shall properly plan the equipment usage against the work schedule to identify and submit the actual number of trucks, dozers, excavators, compactors and any other construction equipment and allow for proper mobilization to assure that demand for the equipment is not over or understated.

The SUBCONTRACTOR shall provide sufficient water trucks to provide dust control on all construction and access road (including the Construction Access Road from Route 3 to the east gate of the ERDF fence) and for compaction activities.

Prior to on-site equipment mobilization, the SUBCONTRACTOR must provide necessary testing to ensure that the equipment will operate satisfactorily and safely in accordance with CONTRACTOR requirements and specifications. It shall include at a minimum the required hydrostatic, pneumatic, electrical, ventilation, and mechanical functioning.

The SUBCONTRACTOR shall have sufficient spare parts available on site, or the capability to deliver to the site in such a manner that the construction schedule is not compromised.

2.2 FUELING STORAGE AND DELIVERY SYSTEMS

The SUBCONTRACTOR may elect to install a fueling tank in the construction maintenance area or have regular or overnight delivery of gasoline, diesel fuel and oil, in sufficient quantities such as the production and schedule are not compromised.

Any proposed fuel storage tanks for onsite distribution of diesel fuel and gasoline shall be located above ground and provided with secondary containment features. Any gasoline fueling station shall include an open-sided shelter to minimize the effects of the hot desert sun. If fuel or other fluids are spilled outside of secondary containment area(s), SUBCONTRACTOR shall remove impacted area and properly dispose of said material.

2.3 EQUIPMENT MAINTENANCE

2.3.1 General

Daily and regular service and maintenance of the equipment shall be performed in the construction maintenance area, or, with prior CONTRACTOR's approval at the location where the respective equipment operates. For major repairs requiring long time duration, the SUBCONTRACTOR shall remove the equipment from the site and promptly replace it with a similar piece of equipment.

SUBCONTRACTOR shall provide vehicle fuel and regular preventive maintenance services for the duration of the subcontract performance period. SUBCONTRACTOR shall perform timely repairs to all equipment found to be in need of repair, prior to operation.

2.3.2 Inspections and Maintenance

Equipment brought to the site shall be maintained and operated as intended by the manufacturer; shall be in good working condition; and shall be free of residual dirt, oil, or grease. Cracked or broken glass shall be promptly replaced. No modifications or additions that affect the capacity or safe operation of the equipment shall be made without the manufacturer's and CONTRACTOR's written approval. If such modifications or changes are made, the capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly. All construction and transportation equipment shall be inspected (including functional checks) at the beginning of each shift to ensure that the equipment is in safe operating condition and free of damage or wear and tear that could cause failure while in use. The inspections shall be documented prior to using the equipment.

The SUBCONTRACTOR shall maintain an orderly file of equipment maintenance, inspection, and repair records available for CONTRACTOR review for the duration of the Subcontract.

The SUBCONTRACTOR shall use only manufacturer- recommended vehicle fluids.

2.3.3 Equipment Safety

The SUBCONTRACTOR shall correct equipment safety deficiencies immediately throughout the duration of the project. The CONTRACTOR reserves the right to inspect and test the equipment and its setup for safe operation at any time. All construction and transportation equipment shall meet safe operating requirements as prescribed by OSHA.

Vehicles operated on public highways shall comply with all legal requirements. The vehicles shall conform to all applicable federal and Washington State laws, including the following requirements, at a minimum: 46 RCW, 49 CFR (172 Appendix C, 393, 566, 567, 571). The vehicles shall also conform to all applicable Department of Transportation (DOT) regulations. Vehicles shall include the following minimum safety equipment: fire extinguisher, reflector kit, first aid kit, and backup alarm.

In the event that operators, mechanics, or other personnel need to perform work or have access to a height of 6 feet or more on heavy equipment, cranes, or other vehicles, they will need to have a method of primary fall protection as required by OSHA standards on fall protection, 1926.501 (a), (b) and 1926.502 (a), (b). Fall protection may include, but not be limited to: handrails, grab rails, fall arrest systems, aerial lifts, scaffolding, etc.

Front windshields on equipment cabs shall remain closed during excavation and load out operations. All cab glass shall be safety glass, or equivalent, that introduces no visible distortions affecting the safe operation of the equipment or visibility of the operator. Cracked or broken glass on heavy equipment and windows that obscure vision because of scratches, weathering, or scarring shall be immediately replaced. Daily operator inspections shall ensure that no visible distortions or cracked and broken glass is present affecting safe operation. Equipment cabs shall have a climate controlled ventilation system that will allow the cab door and windows to remain closed during operation while providing protection for the operator from weather conditions and dust.

All heavy equipment shall have suitable cab protection from shifting or falling debris or from roll over, consistent with the equipment's intended use and associated hazards.

No modifications or additions, which affect the capacity or safe operation of the equipment shall be made without the manufacturer's and CONTRACTOR's written approval. If such modifications are made the capacity, operation, and maintenance instruction plates, tags or decals shall be changed accordingly. All equipment including attachment usage shall be operated within the manufacturer's safety requirements and rated capacities and capabilities.

No vehicle or equipment (other than an excavator) shall operate within 0.61 m (2 ft) of a properly sloped (1.5H: 1.0V) excavation. The SUBCONTRACTOR shall document the criteria for each activity requiring an OSHA competent person and shall identify its OSHA competent person(s) in writing to the CONTRACTOR. The excavation shall be inspected by the SUBCONTRACTOR'S OSHA competent person in accordance with OSHA 29 CFR 1926 prior

to beginning work each shift or as conditions change. The inspection shall be for signs (or lack thereof) of instability or potential instability to include observations of the following:

- Slumping, depressions, or tension cracks at the top of slopes
- Visible/active sloughing or raveling of side slopes
- Presence of free water on the top of the slope or slope surface.

At a minimum, inspections shall be documented in the SUBCONTRACTOR'S daily report or log book, and shall include review of administrative and engineering controls, as appropriate. If there are observed signs of slope instability, the OSHA competent person shall take immediate corrective action to ensure worker health and safety for necessary activities near the top of the excavation slope and at the excavation entry. No personnel or equipment shall enter the excavation until required corrective measures are completed and documented.

2.3.4 Equipment Operators

Truck drivers/operators must be properly licensed in accordance with applicable State and Federal regulations. All drivers and equipment operators must be properly trained and familiar with the equipment manufacturers' safe operating procedures. Equipment shall be operated by qualified personnel in a manner to safeguard adjacent workers from injury.

Daily documented equipment inspection records must be maintained and available for review upon request

2.3.5 Flagmen and Spotters

Flagmen/spotters shall be provided as needed to assist construction and transportation equipment operators in the safe operation of equipment. Personnel assigned as flagmen/spotters shall be properly trained and familiar with proper hand signaling techniques and safe equipment operating instructions.

2.3.6 Environmental Considerations

The SUBCONTRACTOR shall furnish and maintain dedicated spill kits at the equipment maintenance area while in use, at fueling stations, at oil lubricant stations, at maintenance work areas, and at each heavy equipment location. The spill kits shall contain appropriate material (scoops, shovels, and absorbent materials) for absorbing a liquid spill of at least 208 L (55 gal). The kit shall be marked "SPILL KIT" and containerized to protect the kit contents from the elements (i.e., rain, snow, wind, etc.). Kit contents shall be completely replaced within 24 hours after use.

The SUBCONTRACTOR shall dispose of equipment maintenance wastes in accordance with applicable state and federal regulations and Exhibit "J."

The SUBCONTRACTOR shall manage vehicle waste including disposal and recycling as appropriate.

3.0 EXECUTION

3.1 INTEGRATED WORK CONTROL

Equipment maintenance Work shall be conducted in accordance with the Integrated Work Control Program (IWCP) requirements specified in Exhibit "B" SC-47. SUBCONTRACTOR shall ensure personnel are trained and qualified in accordance with the IWCP. The following types of equipment maintenance activities require an IWCP work package to perform/control the work:

1. rigging, hoisting and lifting
2. jacking
3. blocking and bracing to prevent energy release
4. abnormal loading and offloading of equipment, parts, or materials, from transportation conveyances (i.e. using a boom of a track hoe to load the track hoe, jacking a piece of equipment to position or load it, recovery operations due to improper loading, etc.)
5. cutting, welding, or grinding
6. elevated work
7. recovery operations for turned over, stranded, or disabled equipment (normal towing operations [equipment is on its wheels] are excluded, CONTRACTOR approval required)
8. changing of split rim tires, removing/replacing of tires/wheels in excess of 120 lbs
9. other maintenance or recovery operations that could involve hazards such as working near an open excavation, hot work, electrical shock, high pressure releases, etc.

SPECIFICATION FOR

DOCUMENT CONTROL *mjp 10/11/07*

TECHNICAL SPECIFICATION FOR PIPE, VALVES, & SPECIALS

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)

CELLS 7, 8, 9 & 10 CONSTRUCTION

WASHINGTON CLOSURE HANFORD		JOB NO. 14655	
SUPPLIER/SUBCONTRACTOR DOCUMENT STATUS STAMP			
1. <input checked="" type="checkbox"/> Work may proceed. 2. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission. 3. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission subject to resolution of indicated comments. 4. <input type="checkbox"/> Revise and resubmit. Work may not proceed. 5. <input type="checkbox"/> Permission to proceed not required.			
Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the supplier/subcontractor and does not relieve supplier/subcontractor from full compliance with contractual obligations or release any "holds" placed on the contract.			
CIVIL MECHANICAL ELECTRICAL PIPING INSTRUMENTATION CHEMICAL SAFETY ENVIRONMENTAL SPECIALS OTHER	PROJECT CHECK REVISIONS COMMENTS APPROVALS DATE SIGNATURE	PROJECT CHECK REVISIONS COMMENTS APPROVALS DATE SIGNATURE	PROJECT CHECK REVISIONS COMMENTS APPROVALS DATE SIGNATURE
CHECKED BY: <i>Bill Borlaug</i> 10/9/07 PROJECT ENGINEER (P.E.)			
DOCUMENT ID NUMBER 0600X-SC-60524 05-18 012		SUBMITTAL	



EXPIRES 11-22-08

500X524A00

Rev.	Date	Reason for Revision	Originator	Checker	Project Engineer	LEAD Design Eng.
0	9-28-07	Issued for Construction	<i>TKS</i>	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
Washington Closure Hanford, LLC		RIVER CORRIDOR CLOSURE CONTRACT	Job No. 14655 Specification No. 0600X-SP-M0029 Page 1 of 34			

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WCH - DOCUMENT CONTROL

PIPE, VALVES, AND SPECIALS

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PIPING, VALVES, AND SPECIALS

1.0 GENERAL

1.1 SUMMARY

This specification establishes quality and workmanship requirements and defines how quality is measured for the Piping, Valves, and Specials.

1.2 ABBREVIATIONS

The abbreviations listed below, as used in this specification, shall have the following meaning:

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AWWA	American Water Works Association
CFR	Code of Federal Regulations
GSA	U.S. General Services Administration
MSS	Manufacturers Standardization Society of the Valves and Fittings Industry
NFPA	National Fire Protection Association
ERDF	Environmental Restoration Disposal Facility
HDPE	High Density Polyethylene
PVC	Polyvinyl Chloride
SDR	Standard Dimension Ratio
SSRS	Subcontractor/Supplier Submittal Requirements Summary
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
OSHA	Occupational Safety and Health Administration
VARV	Vacuum/Air Release Valve
VRV	Vacuum Release Valve

1.3 REFERENCES

49 CFR 192.285	Plastic pipe: qualifying persons to make joints.
ANSI/ASME	Applicable B31 Standards
29 CFR 1910	Occupational Safety and Health Standards
49 CFR 192	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

1.4 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Piping, Valves, and Specials. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Piping, Valves, and Specials. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

ASTM A 53/A 53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123/A 123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 193/ A 193M	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Temperature Service and Other Special Purpose Applications
ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A 312/A 312M	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Pipes
ASTM A 351/A 351M	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 403/A 403M	Standard Specification for Wrought Austenitic Stainless Steel Pipe Fittings
ASTM A 743/A 743M	Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
ASTM A 744/A 744M	Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
ASTM A 813/A 813M	Standard Specification for Single- or Double-Welded Austenitic Stainless Steel Pipe
ASTM A 814/A 814M	Standard Specification for Cold-Worked Welded Austenitic Stainless Steel Pipe
ASTM A 815/A 815M	Standard Specification for Wrought Ferritic, Ferritic/Austenitic, and Martensitic Stainless Steel Piping Fittings

ASTM C 478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM D 792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1784	Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D 1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2000	Standard Specification for Rubber Products in Automotive Applications
ASTM D 2241	Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2464	Standard Specification for Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	Standard Specification for Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2513	Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D 2564	Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems
ASTM D2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D 2855	Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings

ASTM D 2683	Standard Specification for Socket-Type Polyethylene Fittings for Outside-Diameter Controlled Polyethylene Pipe and Tubing.
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fitting Materials
ASTM F 593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 1476	Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications
ASME B1.20.1	Pipe Threads, General Purpose (Inch)
ASME B 16	Standards of Pipes and Fittings
ASME B16.1	Cast iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250
ASME B16.3	Malleable Iron Threaded Fittings,
ASME B16.34	Valves-Flanged, Threaded, and Welding End
ASME B 16.5	Pipe Flanges and Flanged Fittings
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.9	Building Services Piping
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe
AWWA C104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	American National Standards for Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings, for Water
AWWA C111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115/A21.15	American National Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151/A21.51	Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/A21.53	Ductile-Iron Compact Fittings for Water Service
AWWA C207	Steel Pipe Flanges for Waterworks Service -Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C500	AWWA Standard for Metal-Seated Gate Valves for Water Supply Services
AWWA C502	AWWA Standard for Dry-Barrel Fire Hydrants
AWWA C504	Rubber-Seated Butterfly Valves
AWWA C509	Standard for Resilient-Seated Gate Valves for Water Supply Service
AWWA C511	Standards for Reduced-Pressure Principle Backflow-Prevention
AWWA C600	Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution
AWWA M23	PVC Pipe - Design and Installation
GSA FS RR-W-410	Wire Rope and Strand
MSS SP - 58	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP - 69	Pipe Hangers and Supports - Selection and Application
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
NFPA 24	Standard for the Installation of Private Fire Service Mains and their Appurtenances

NFPA 49	Hazardous Chemicals Data
NFPA 325M	Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	Standard System for the Identification of the Hazards of Materials for Emergency Response

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "I", Subcontractor/Supplier Submittal Requirements Summary (SSRS). Submittals that do not meet the requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.5.1 Manufacturer's Information

Printed copies of the manufacturer's literature stating materials of construction, applicable standards, capacities, rated pressures, and other product information indicate compliance with the project specifications.

1.5.2 Installation Instructions

The manufacturer's recommendations for each material or procedure will be utilized.

1.5.3 Statement of Satisfactory Installation

A statement signed by the SUBCONTRACTOR's principal officer stating that the installation is satisfactory and in accordance with the Subcontract plans, drawings, codes, standards, and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

1.6 GENERAL REQUIREMENTS

This specification covers the procurement, installation, and testing of the leachate, vadose zone monitoring, and raw water (if used) systems. The SUBCONTRACTOR shall have a copy of the manufacturer's instructions available at the construction site and shall follow those instructions unless directed otherwise by the CONTRACTOR. Before, during and after installation pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Backfilling shall be accomplished after inspection by the CONTRACTOR and others. The SUBCONTRACTOR shall replace damaged materials and redo unacceptable work at no additional cost to the CONTRACTOR.

1.7 DELIVERY, STORAGE AND HANDLING

Materials and equipment shall be handled so as to insure delivery to the site in sound, undamaged condition. Materials and equipment shall be stored with protection from weather, humidity and temperature variations, dirt and dust, or other contaminants, in accordance with code and standard requirements and manufacture's recommendations. Proper protection and care of materials before, during, and after installation shall be the SUBCONTRACTOR's responsibility. Any materials found to be damaged or unacceptable shall be repaired or replaced at SUBCONTRACTOR's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

2.0 MATERIALS AND EQUIPMENT

2.1 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE AND FITTINGS

- a) Pipe 100 mm (4-in.) through 300 mm (12-in.) Diameter shall conform to AWWA C900, Class 200, CIOD pipe dimensions, elastomeric-gasket joint, unless otherwise shown or specified.
 - 1) For pipe 100 mm (4 in.) diameter and larger: Fittings and specials shall be ductile iron, bell end in accordance with AWWA C110, 2.42 MPa (350 psi) pressure rating unless otherwise shown or specified, except that profile of bell may have special dimensions as required by the pipe manufacturer. Fittings and specials constructed of the same material as the pipe shall be fitted with elastomeric gaskets in conformance with AWWA C900. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104. Fittings shall be bell and spigot or plain end pipe, or as applicable. Ductile iron compact fittings shall be in accordance with AWWA C153. (Specials: special ductile iron pipe fittings to meet out-of-the-ordinary construction requirements, including welded outlets, wall sleeves, thrust collar/water stops, saddle outlets, castings, bell-less ductile iron pipe for trenchless installation, and fittings with unique combinations of joints.)
- b) Pipe Less Than 100 mm (4-in.) Diameter:
 - 1) Pipe Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.

Threaded Nipples: Schedule 80 PVC.
 - 2) Fittings Schedule to Match Pipe: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.

- 3) Joints Solvent socket-weld except where connection to threaded valves and equipment that require disassembly.
- 4) Flanges One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
- 5) Bolting ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/ A194M Grade 8M hex head nuts.
- 6) Gaskets
 Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber.

 Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
- 7) Solvent Cement and primer as recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
- 8) Thread Lubricant Teflon Tape.

2.2 HDPE PIPE

This section includes High Density Polyethylene (HDPE) Pipe used in the ERDF landfill including but not limited to:

1. Leachate collection piping on floor and cleanout access pipes on the slopes of the trench.
2. Side-slope riser pipes containing submersible sump pumps and level transducers.
3. Sump pump discharge piping.
4. Prefabricated HDPE boots to be placed around all pipe penetrations through the HDPE liner.
5. Double containment piping from Crest Pad Buildings to manholes as shown on the Drawings.

HDPE pipe shall conform to ASTM D3350 high-density polyethylene, minimum cell classification values of 345434C with maximum allowable hoop stress 800 psi at 73.4 degrees F.

Pipe joints, fittings and flanged connections shall be joined by thermal butt-fusion.

2.2.1 Resin

Polyethylene resins shall conform to Type PE 3408 or CONTRACTOR approved alternate.

Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin.

2.2.2 Quality

The pipe shall have uniform wall thickness and shall be uniform in color, opacity, density, and other physical properties. Pipe shall be homogeneous throughout and free of visible cracks, holes, blisters, bubbles, undispersed raw materials, or any contamination by foreign matter. Any pipe with nicks, scrapes, or gouges deeper than 25 percent of the nominal wall thickness shall be rejected.

2.2.3 Form

Pipe may be supplied in a continuous extruded seamless piece or in sections.

2.2.4 Manufacturer's QC Certificates

Prior to shipment, the HDPE pipe Manufacturer shall submit a quality control certificate for each lot/batch of HDPE pipe provided. A responsible party employed by the HDPE pipe Manufacturer, such as the Production Manager shall sign the quality control certificate. The quality control certificate shall include both:

- a) Lot/batch numbers and identification.
- b) Sampling procedures and results of quality control tests.

2.3 HDPE DOUBLE CONTAINMENT PIPE

2.3.1 Pipe Materials

Both carrier pipe and containment pipe shall meet the requirements of HDPE Pipe of this section.

2.3.2 Configuration

Double containment pipe shall consist of factory pre-fabricated components, with a carrier pipe installed within a containment pipe. Pipe and fittings shall provide a continuous annular space between the carrier and containment pipes to accommodate monitoring systems and flow of fluid from the carrier pipe leakage.

2.3.3 Support Spacers

Carrier pipe support spacers shall be HDPE sheet stock ½-inch thick minimum. The support spacing shall be per pipe manufacturer's recommendations and as approved by the CONTRACTOR. The spacers shall maintain the specified annulus between the carrier and containment pipes and shall allow for unrestricted passage of monitoring systems and possible flow of fluid from the carrier pipe. SUBCONTRACTOR is to provide an assembled sample of

carrier pipe, spacers, and containment piping the SUBCONTRACTOR is planning to utilize, for CONTRACTOR inspection and approval, prior to ordering the material.

2.3.4 End Seals

Expansion type end seals or fixed end caps shall be used to seal the annulus between the carrier and containment pipes. End seals shall include side ports for monitoring systems or to drain fluid from the annulus. End seals shall be factory manufactured.

2.3.5 HDPE Fittings

Fittings shall conform to the requirements of HDPE Pipe of this section and shall be compatible with the other components of the double containment system. Fittings shall be pre-fabricated with the carrier fitting installed within the containment fitting and containment pipe support spacers installed.

2.4 HDPE COUPLINGS AND END CAPS

2.4.1 Couplings

Couplings for socket fusion shall satisfy the specifications for HDPE Pipe, except that other cell classifications are acceptable provided that they are compatible with the HDPE pipe and provide equivalent performance to class 345434C. Couplings shall satisfy the requirements of ASTM D2513 and shall be manufactured in compliance with ASTM D2683.

2.4.2 Flanged Connections

Where pipes or fittings of different materials are connected, the coupling shall be a flanged connection. The flanges shall be ANSI 150-pound class flanges. The flange joints shall use stainless steel nuts, washers, and bolts. Gaskets shall be utilized when joining to nonpolyethylene materials.

2.4.3 End Caps

Provide molded polyethylene end caps for ends of cleanout access pipes. Caps shall prevent entry of soil or debris into the cleanout pipe and shall be removable. Composition of polyethylene shall be compatible with cleanout pipes per manufacturer's recommendations and shall withstand outdoor conditions.

2.5 PERFORATIONS AND PENETRATIONS

2.5.1 Leachate Collection Piping

Leachate collection piping on the floor of the landfill shall be perforated. Perforations shall be as shown on the drawings. Cleanout access pipes shall not be perforated.

2.5.2 Sump Pipes

The sump pipes (lower portion of the side slope riser pipes within the sump gravel) shall be perforated as shown on the drawings.

2.6 HDPE FLATSTOCK

2.6.1 Resin

Flatstock shall meet or exceed ASTM D1248 requirements for Type III, Class A, B, or C; Category 3; Grade G5. Flatstock shall be manufactured from first quality polyethylene resin containing no more than 2% clean recycled polymer by weight.

2.6.2 Material Properties

The flatstock shall meet the requirements for specific gravity, carbon black content, and melt index as specified for HDPE Pipe.

2.6.3 Thickness

The flatstock used in the primary sump shall have a nominal thickness of one inch. The edges of the flatstock shall have a 6.4 mm (0.25 in.) bevel.

2.7 BOOTS

The SUBCONTRACTOR shall supply prefabricated HDPE boots conforming to the requirements for geomembrane for miscellaneous applications presented in the Technical Specifications for Cell Construction for penetrations of HDPE pipe through the geomembrane liner, i.e., 0600X-SP-C0068, "Geosynthetics", and 0600X-SP-C0069, "Leachate Collection".

2.8 HDPE PIPE SCHEDULE

HDPE pipe nominal diameter and wall thickness shall be as follows:

Submersible pump discharge piping	1 ½" diam. SDR 11
Submersible pump discharge piping	3" diam. SDR 11
Sump level transducer access pipe	Primary 6", Secondary 12"diam. SDR 11
Slope riser pipe	12" diam. SDR 13.5
Slope riser pipe	18" diam. SDR 13.5
Double containment pipe 2/6	2" diam. SDR 11/6" diam. SDR 17
Double containment pipe 4/8	4" diam. SDR 11/8" diam. SDR 17
Double containment pipe 10/14	10" diam. SDR 11/14" diam. SDR 17
Perforated leachate collection	4" diam. SDR 11
Perforated leachate collection	6" diam. SDR 11

Cleanout access pipes	6" diam. SDR 11
Raw water piping	3" diam. SDR 11
Lysimeter Access Pipe (perforated and solid walled)	6" diam. SDR 11

2.9 STAINLESS STEEL PIPE

This section includes Stainless Steel Pipe used in the ERDF landfill including but not limited to:

1. Vadose zone monitoring pipes installed beneath Cells 7 and 8.

Stainless steel pipe shall meet the requirements of ASTM A 312/A 312M, for welded pipe; ASTM A 813/A 813M for fit-up and alignment quality, Class SW; ASTM A 814/A 814M for flanged and cold-bending quality, Class SW; Grade TP304; Schedule 40S with dimensions conforming to ASME B36.19M.

Pipe joints, fittings, and flanged connections shall be joined using Victaulic® mechanical couplings.

2.9.1 IPS Grooved Piping System

Victaulic grooved mechanical pipe couplings and fittings shall be used. All grooved components shall be of one manufacturer Victaulic Company of America, and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or ICC. Grooved end product manufacturer shall be ISO-9001 certified. Grooved couplings shall meet the requirements of ASTM F 1476.

2.9.2 Pipe/Grooved (Standard/Lightwall)

Stainless Steel, ASTM A 312 - Cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Since the interior of the monitoring pipes must be smooth, roll-grooved pipe may not be used. Pipe ends are to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606.

2.10 VICTAULIC MECHANICAL COUPLINGS FOR JOINING STAINLESS STEEL PIPE

2.10.1 Mechanical Couplings

Coupling used to join pipes beneath the cell floor shall be Style 489 Rigid Stainless Steel Couplings used to joining pipes beneath the cell sideslope shall be Styles 475 and 77-S Flexible Stainless Steel, type 316, conforming to ASTM A 351, A 743, and A 744 Grade CF-8M.

2.10.2 Mechanical Coupling Bolts and Nuts

Coupling bolts and nuts shall be Type 316 Stainless Steel, oval neck track bolts and heavy hex nuts with chemical and physical properties of ASTM A 193, Grade B8M, Class 2 or ASTM F 593, Group 2, Condition CW.

2.10.3 Victaulic Gaskets

Gaskets used in all mechanical couplings shall be Grade "E" EPDM compound (green color coded) conforming to ASTM D-2000 designation 2CA615A25B24F17Z.

2.11 STAINLESS STEEL FITTINGS

Victaulic fittings shall be smooth turn full flow stainless steel fittings or segmentally welded fittings with grooves designed to accept Victaulic grooved end couplings. Fittings will be Schedule 40 stainless steel, to provide a smooth interior for the vadose zone monitoring pipes.

2.12 VALVES

2.12.1 Gate Valves

Gate valves shall be designed for a working pressure of not less than 1.38 MPa (200 psi). Valve connections (the connection shall allow for replacement/removal of the valve) shall be as required for the piping in which they are installed. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel..

- a. Valves 80 mm (3 in.) and larger shall be iron body resilient seat, bronze mounted, non-rising stem and shall conform to AWWA C509. An approved pit, as defined on drawings 0600X-DD-M0022 and 23, shall be provided for flanged connections.

2.12.2 Vacuum/Air Release Valves

Vacuum / air release valves shall be constructed of corrosion-resistant material and function as both air release and vacuum breaker valves. Drain line for vacuum/air release valves shall match diameter of vacuum/air release valve drain port.

Vacuum/Air Release valves shall be GA Industries Figure 930 or CONTRACTOR approved alternate.

2.12.3 Vacuum Relief Valves

Vacuum relief valves wet parts shall be constructed of corrosion resistant materials.

Vacuum Relief Valves shall be manufactured by Plast O Matic Model VBM 100V-PV CONTRACTOR approved alternate.

2.12.4 Motor Actuated Plug Valves (2-V-19, -20, -21 and 2-V-22)

Eccentric plug valves, as shown on 0600X-DD-M0022, shall be of the non-lubricated eccentric type with cast iron bodies, resilient faced plugs, or a replaceable, resilient seat in the body. Resilient facing shall be suitable for the intended service. Valves shall have an unobstructed port area of not less than 80 percent of full pipe area, unless otherwise specified. Eccentric plug valves shall have a pressure rating of not less than 1.38 MPa (200 psi) WOG, for bubble-tight shut-off. Plug valves and electric actuator manufacturer and model shall match plug valves in existing manhole 23 and 24 or CONTRACTOR approved alternate.

2.12.4.1 Motorized Valve Actuator

Equipment Requirements: Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adapter piece.

Gearing. The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches and limit switches in a weatherproof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm gearing. The spur or helical gears shall be of hardened alloy steel and the worm gear shall be alloy bronze. Gearing shall be accurately cut with hobbing machines. Power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the electric actuator.

Starting Device. Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.

Switches and Wiring. Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by a pulse-counter that receives 15 pulses per rotation of the unit. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The actuator shall have a number of gear trains as required to produce the operation indicated. The actuator shall be wired in accordance with the schematic diagram. Wiring for external connections shall be connected to marked terminals. One 25 mm (1 in.) and one 32 mm (1 1/4 in.) conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial setting to the unit output torque. Position limit switches and associated gearing shall be an integral part of the valve

actuator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of stainless steel, grease-lubricated, and enclosed in its own gear case to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Traveling-nuts, cams, or microswitch tripping mechanisms shall not be used. Limit-switches shall be of the heavy-duty open contact type with rotary wiping action.

Handwheel Operation. A permanently attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 81 N-M (60-lb-ft), and the maximum force required on the rim of the handwheel shall not exceed 267 N (60 lb). An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.

Motor. The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 480-volt, 3-phase, 60-Hz current, and have Class F insulation and a motor frame with dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C (131 degrees F) above an ambient temperature of 40 degrees C (104 degrees F) when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to dropout. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire actuator is a hermetically-sealed, non-breathing design with a separately sealed terminal compartment that prevents moisture intrusion.

Actuator Appurtenances. The actuator for each valve shall be supplied with open and close status lights, open, close and lock-out-stop push-buttons, and other devices indicated.

Starter. The starter shall be a suitably sized amperage rated reversing starter with its coils rated for operation on 120-volt, 1-phase, 60-Hz current. A control power transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset type. Its control circuit shall be wired in accordance with drawing and manufacturer's instructions. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components.

2.12.5 Reduced Pressure Backflow Preventer

Two check valves, independent relief between the valves resilient seat gate isolation valves testing cock, in accordance with AWWA C511, rated 1.2 Mpa (175-psi) CWP, meets requirements of USC Cross Connection Control Laboratory and shall be certified for use by Washington State Department of Health.

- a. Manufacturers and Products
- 1) WATTS: Series 909
 - 2) or CONTRACTOR approved alternate.

2.12.6 Ball Check Valves

Furnish and install check valves sized as shown on the Drawings. ASTM D1784, Type I, Grade I polyvinyl chloride body, single or dual union socket weld ends, rated 1034.2 kPa (150 psi) at 48.9 degrees C (120 degrees F), and Viton seat and seal.

Ball check valves shall be Hayward True Union or CONTRACTOR approved alternate.

2.12.7 Ball Valves

Furnish and install ball valves sized as shown on the Drawings. Rated 1034.2 kPa (150 psi) at 48.9 degrees C (120 degrees F), with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball and stem, end entry, double union design, solvent weld socket ends, or single union ball valve with flanged ends drilled to ASME B 16.5, Class 150, elastomer seat, Viton or Teflon O-ring stem seals, full ported ball. Ball valves shall be Hayward True Union or contractor approved alternate.

2.12.8 Valve Schedule (Each Crest Pad Building)

<u>Valve No.</u>	<u>Description</u>
CV1	38 mm (1 1/2 in) check valve
CV2	38 mm (1 1/2 in) check valve
CV3	76 mm (3 in) check valve
VARV1	19 mm (3/4 in) Vacuum/ air release valve, leachate discharge line (low capacity pump)
VARV2	19 mm (3/4 in) Vacuum/ air release valve, leachate discharge line (low capacity pump)

VARV3	32 mm (1 1/4 in) Vacuum/ air release valve, leachate discharge line (high capacity pump)
VRV1	19 mm (3/4 in) Vacuum release valve, low capacity discharge line
VRV2	19 mm (3/4 in) Vacuum release valve, low capacity discharge line
VRV3	25 mm (1 in) Vacuum release valve, high capacity discharge line
VRV4	25 mm (3 in) Vacuum release valve, gravity drain line
BV1	38 mm (1 1/2 in) manually operated ball valve, discharge line
BV2	38 mm (1 1/2 in) manually operated ball valve, recirculation line
BV3	102 mm (4 in) manually operated ball valve
BV4	51 mm (2 in) manually operated ball valve

2.13 FLOW METERS

The SUBCONTRACTOR shall furnish and install meters and flow measurement devices with associated instrumentation and controls as shown and specified herein, complete and operable, for functions including flow measurement and batch metering of fluids including leachate, in accordance with the requirements of the Subcontract Documents.

2.13.1 Paddle Meters

The SUBCONTRACTOR shall furnish and install the following paddle meters:

LD. No.	Service	Location/ Cell	Pipe Size	Flow Range	Inlet Pressure in W.C.	Service Temp.
2-M-20	Leachate	7	50.8 mm (2 in.)	0-12.6 l/s (0-200 gpm)	15.24 m (50 ft)	21 °C (70 °F)
2-M-21	Leachate	7	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-22	Leachate	7	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-23	Leachate	8	50.8 mm (2 in.)	0-12.6 l/s (0-200 gpm)	15.24 m (50 ft)	21 °C (70 °F)
2-M-24	Leachate	8	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)

I.D. No.	Service	Location/ Cell	Pipe Size	Flow Range	Inlet Pressure in W.C.	Service Temp.
2-M-25	Leachate	8	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-26	Leachate	9	50.8 mm (2 in.)	0-12.6 l/s (0-200 gpm)	15.24 m (50 ft)	21 °C (70 °F)
2-M-27	Leachate	9	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-28	Leachate	9	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-29	Leachate	10	50.8 mm (2 in.)	0-12.6 l/s (0-200 gpm)	15.24 m (50 ft)	21 °C (70 °F)
2-M-30	Leachate	10	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)
2-M-31	Leachate	10	19.1 mm (3/4 in.)	0-1.6 l/s (0-25 gpm)	21.34 m (70 ft)	21 °C (70 °F)

The paddle wheel insertion meter shall be constructed of materials suitable for the intended service. The meter stem shall contain an electronic pickup, sensing the passage of each rotor blade. A pulsed output obtained shall produce a repetition rate directly related to flow velocity. The meter shall be capable of registering flow with an accuracy of ± 2 percent over a 10 to 1 range, with a negligible pressure loss.

The meter inserts shall be made of Type 316 stainless steel or of plastic material suitable for the intended service. The shaft material shall be stainless steel, titanium, or Hastelloy. The paddle wheels shall be of Type 316 stainless steel or suitable plastic.

The meter inserts shall be mounted securely through a screwed, flanged, welded, or socket-welded tee connection or fitting, for precise positioning in the pipeline. The fittings shall be of the same material as the pipeline unless otherwise called out. The mounting hardware or probe shall include a clear indicating device to correctly position the meter insert in the pipeline.

A transmitter shall be provided for remote indication of flow and totalized quantity.

The Paddle Meter shall be +GF+Signet Model No. P51530-PO or CONTRACTOR approved alternate.

2.14 MANHOLES

Precast reinforced concrete manhole sections shall conform to ASTM C 478. Joints shall be cement mortar, or an approved mastic or rubber gasket, or an approved combination of these types. Ladders shall be constructed on OSHA 1910 safety standards. Steel ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123.

2.15 FLOOD SWITCHES

Flood switches shall be of the type that traps air in an inverted column. Contact transfer is initiated by a pressure switch actuated by increasing pressure in the column. The pressure switch shall be isolated from the process with a diaphragm. Flood switches shall be water tight and capable of being submersed without adversely effecting electrical signal components. Flood switches shall be same manufacturer and model as existing flood switches in manhole 23 and 24 (or CONTRACTOR approved alternate), refer to 0600X-DD-M0024.

2.16 MISCELLANEOUS ITEMS

2.16.1 Valve Nameplates

Exposed valves shall have an attached stainless steel nameplate to list the manufacturer's name, address, component type or style, model or serial number, catalog number, capacity or size, and the system that is controlled. Plates shall be fixed in prominent locations with nonferrous screws or bolts. Valves shall be tagged with valve number in accordance with drawings.

2.16.2 Service Clamps

Service clamps shall have a pressure rating not less than that of the pipe to be connected and shall be the double flattened strap type. Clamps shall have a galvanized malleable-iron body with cadmium-plated straps and nuts. Clamps shall have a rubber gasket cemented to the body.

2.16.3 Pipe Supports

Drawings may not indicate pipe supports necessary to adequately support piping. Pipe supports in crest pad building shall consist of prefabricated galvanized double channel sections commercially manufactured for this purpose. Supports shall allow for vertical adjustment after erection. Supports shall be capable of supporting the piping and associated equipment as shown on the Drawings. Pipe shall be attached to channel sections using standard pipe clamps of correct dimension for the pipe. Pipe supports and accessories shall be hot-dipped galvanized and shall be provided from a single manufacturer. Pipe supports and accessories shall conform to MSS SP-58 and MSS SP-69.

2.17 WIRE ROPE SYSTEM

A wire rope system shall be installed through each of the stainless steel vadose zone monitoring pipes, for purposes of pulling an instrument through the entire length of the pipe. The wire rope shall be 0.25-inch diameter, AISI grade 316 stainless steel, 7x19 strand configuration.

2.17.1 Quantity

The SUBCONTRACTOR shall furnish three wire ropes with end terminations (sockets) at both ends.

2.17.2 Wire Strength and Ductility

The Manufacturer shall perform testing in accordance with FS RR-W-410 to verify wire strength and ductility.

2.17.3 Pre-forming

The wire rope shall be pre-formed, and the manufacturer shall perform testing in accordance with FS RR-W-410 to verify pre-forming.

2.17.4 Stress Relief

The wire rope shall be stress relieved, and the manufacturer shall perform testing in accordance with FS RR-W-410 to verify stress relief.

2.17.5 Lubrication

The wire rope shall not be lubricated.

2.17.6 Pitch Length

Strand pitch length shall not be less than 4-1/2 times the nominal rope diameter.

2.17.7 Core Strand Wires

The number of wires in the core strand shall be equal to or greater than the number of wires in the other strands. The wires shall be of the same material as the wires in the other strands, or of a material with a lower tensile strength.

3.0 EXECUTION

3.1 PIPE INSTALLATION

3.1.1 Cutting of Pipe

Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise recommended by the manufacturer and authorized by the CONTRACTOR, cutting shall be done with an approved type mechanical cutter. Wheel cutter shall be used when practicable. Squeeze type mechanical cutters shall not be used for ductile iron or stainless steel pipe.

3.1.2 Joint Deflection

3.1.2.1 Flexible Plastic Pipe. Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the CONTRACTOR, but in no case shall it exceed 5 degrees.

3.1.3 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, belt slings, or other CONTRACTOR approved equipment. Under no circumstances shall any of the water-line materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Except where necessary to make connections with other lines or as authorized by the CONTRACTOR, pipe shall be laid with the bells facing in the direction of laying. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and re-laid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. Water shall be kept out of the trench until joints are complete. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the SUBCONTRACTOR at his expense in a satisfactory manner. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored, as shown.

3.1.3.1 Plastic Pipe Installation. PVC shall be installed in accordance with AWWA M23.

3.1.4 Connections

Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions. Where made under pressure, these connections shall be installed using standard methods as approved by the CONTRACTOR.

3.1.5 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves unless shown otherwise on the Drawings. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.6 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.7 Jointing

3.1.7.1 Polyvinyl Chloride (PVC) Plastic Pipe

- a. Pipe less than 100 mm (4 in.) diameter: Threaded joints shall be made by wrapping the male threads with approved thread tape or applying a CONTRACTOR approved lubricant, then threading the joining members together. The joint shall be tightened using strap wrenches to prevent damage to the pipe and fitting. To avoid excessive torque, joints shall be tightened no more than one thread past hand-tight. Solvent cement joints shall use sockets conforming to the requirements of ASTM D 2467. The solvent cement used shall meet the requirements of ASTM D 2564; the joint assembly shall be made in accordance with ASTM D 2855 and the manufacturer's specific recommendations.
- b. Pipe 100 mm (4 in.) through 300 mm (12 in.) diameter: Joints shall be elastomeric-gasket as specified in AWWA C900. Jointing procedure shall be as specified for pipe less than 100 mm (4-in.) diameter with configuration using elastomeric ring gasket.

3.1.7.2 Connections. Connections between different types of pipe and accessories shall be made with transition fittings approved by the CONTRACTOR.

3.1.8 Crest Pad Valves and Drain Lines

Valves shall be installed in accordance with AWWA Standards and manufacturer's recommendations. Connect VRVs and VARVs to piping by tee fitting, or other method approved by the CONTRACTOR.

- a. Vacuum/air release valve drain lines shall penetrate the caps over the end of the riser pipes in a neat manner to provide at least the same quality of seal as other penetrations. Drain lines shall extend 0.9 to 1.5 m (3 to 5 ft) into the associated riser pipes.

3.1.9 Pipe Supports

The pipe support system shall be installed in accordance with MSS SP-58, MSS SP-69, and the piping support system manufacturer's recommendations. Piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.

3.2 HDPE PIPE INSTALLATION

- a. Pipe shall be handled and stored in such a manner as to ensure a sound, undamaged condition.
- b. Pipe shall be cut in a neat, workmanlike manner using a CONTRACTOR (based on manufacture information) approved mechanical cutter that will not damage the pipe.

- c. Joining of HDPE pipe to HDPE pipe shall be accomplished by thermal butt or socket fusion; no solvent or adhesive welding shall be allowed. Pipe shall be joined per ASTM D2657 Section 9 and manufacturer's recommendations. Installation personnel who join HDPE pipe shall be experienced and certified in accordance with pertinent sections of 49 CFR 192.285. The SUBCONTRACTOR shall submit a list of proposed joining personnel and their qualifications.

Single butt fusion welds shall be used to create pipe sections as long as practicable or as specified in the SUBCONTRACTOR's procedure. Fabricated pipe sections and fittings shall be joined by the double butt fusion process.

- d. During installation, the pipe shall not be pulled across sharp projections that could cause gouges, kinks, or other types of damage.
- e. The pipe shall not be dropped into the trench. The full length of the pipe shall be firmly bedded on the trench bottom. The pipe shall be bedded in such a way as to maintain grade with a tolerance of -0.0%, +0.5%.
- f. Temporarily close pipe ends as required to avoid introducing dirt or other foreign material into the pipe.
- g. Trenching and backfilling operations shall be conducted in accordance with the requirements of the Technical Specification for Site Work. Backfilling operations shall ensure that no voids are present under and at the sides of the pipe. Backfill shall initially be placed to the top of the pipe, and then hand compacted. The remainder of the trench shall then be backfilled and compacted by hand or with a power tamper only.
- h. Where flanged joints are used, the bolts shall be evenly torqued with a crossing pattern to gradually tighten the lug nuts. Flanged joints shall be retorqued after one hour or more has passed. Torque records shall be provided.
- i. Boots shall be welded to the surrounding liner and the HDPE pipe using methods specified in the Technical Specification for Cell Construction-Geosynthetics, as applicable.
- j. Flaws (minor imperfections, damaged areas, etc.) in HDPE pipe with a depth of 10% or less of the nominal wall thickness will not require repair or replacement. In double containment systems, carrier pipes with flaws deeper than 10% of the wall thickness shall be replaced. Single pipe or containment pipe with flaws between 10% and 25% of the wall thickness shall be repaired in accordance with the pipe manufacture's recommendations. The SUBCONTRACTOR shall certify in writing that the repaired area will have material properties that meet or exceed those of intact pipe. Any pipe with flaws deeper than 25% of the nominal wall thickness will be replaced.
- k. HDPE pipe thermal butt or socket fusion welding procedures shall be submitted.

- l. Sideslope Riser Pipes. With pipe in final location, insert submersible pump, discharge piping, and wiring to check pump location and to demonstrate that pipe is free from obstructions. Document and submit this check.
- m. Sump Level Transducer Access Pipes. With pipe in final location, insert to measurement location to demonstrate that pipe is free from obstructions. Document and submit this check.
- n. Weld Beads. Remove internal weld beads from the HDPE pipe installed on the side slopes and in the sumps. Remove debris from inside of pipes. The extracted internal fusion beads shall be subjected to visual inspection and conformation of its removal. Visual inspection shall include:
 - Verification that complete internal fusion bead removal was preformed (This may be accomplished through examination of the extracted internal fusion bead, or by way of CCTV).
 - The extracted internal fusion bead appearance shall have the same double roll back semblance as does the external fusion bead.
 - The extracted internal fusion bead shall possess a smooth root cut, or verification of pipe smoothness by use of CCTV.
 - Removal of the internal bead may include pipe wall mass. However any wall mass that is removed should not exceed 1/10th of the pipe wall thickness itself.

3.3 STAINLESS STEEL PIPE INSTALLATION

- a. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
- b. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
- c. Installation of couplings and fittings shall be performed in accordance with the latest copy of the Victaulic Field Assembly and installation instruction pocket handbook (I-100).
- d. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer (Victaulic Company of America).
- e. The SUBCONTRATOR shall verify electrical continuity of the vadose zone monitoring pipe prior to trench backfill. Continuity clips from the Victaulic Company of America shall be used as needed to maintain continuity on the sideslope where flexible couplings

are used. Testing procedures shall be submitted. CONTRACTOR shall be notified of continuity testing. CONTRACTOR or others shall witness continuity tests. Failure to notify the CONTRACTOR 24 hours, prior to testing, may cause the SUBCONTRACTOR to postpone or perform the test again.

- f. Prior to trench backfill, the SUBCONTRACTOR shall verify that a two-foot long, two-inch diameter rigid rod can be conveyed through bends at the base of the sideslope. CONTRACTOR shall be notified of this testing. CONTRACTOR or others shall witness the conveyance tests. Failure to notify the CONTRACTOR 24 hours, prior to testing, may cause the SUBCONTRACTOR to postpone or perform the test again.

3.4 HYDROSTATIC TESTING

The SUBCONTRACTOR shall perform acceptance testing of HDPE and PVC piping. Where the pipes will be covered with liner, gravel, soil, etc., the SUBCONTRACTOR shall complete the required testing and receive approval by the CONTRACTOR prior to burying the pipe or covering the pipe.

Testing procedures shall be submitted.

CONTRACTOR shall be notified of hydrostatic testing. CONTRACTOR or others shall witness hydrostatic tests. Failure to notify the CONTRACTOR 24 hours, prior to testing, may cause the SUBCONTRACTOR to postpone or perform the test again.

3.4.1 General

Provide test equipment and materials, including test pumps, gages, water, volumetric measuring equipment, and other equipment required. Pressure gages used shall be graduated in increments not greater than 34.5 kPa (1 psi) and shall have range of approximately twice test pressure. Use only calibrated gages and instruments. Provide calibration certificates traceable to NTS. Gage serial numbers shall be traceable to tests performed. Specify the allowable tolerance for testing pressures.

When testing the containment pipe the carrier pipe shall be pressurized to the same test pressure to prevent collapsing of the carrier pipe.

Test in accordance with applicable provisions of ASME B31.3, normal fluid service, as modified by the requirements of this section.

Hold test pressure for 1 hour. Test time will be accrued only while full test pressure is applied to system.

During testing, remove from systems any equipment that would be damaged by test pressure. Replace removed equipment after testing.

Systems may be tested in sections as work progresses: however, any previously tested portion shall become a part of any later test of composite system. Test records shall include marked up drawings indicating which piping was tested.

Where new pipe connects to existing piping, the joint between the two pipes shall be tested. Correct leaks by remaking joints with new material; makeshift remedies will not be permitted.

The SUBCONTRACTOR shall be responsible for providing temporary fillings, plugs, and thrust blocking for testing at the specified pressure.

Leakage shall be zero for the piping at the specified test pressure throughout the specified duration.

Welded pipe attachments (hangers, etc.) shall be installed prior to testing.

3.4.2 HDPE Pump Discharge Pipes

Pressure test to 414 kPa (70 psi) with gage located in crest pad building.

3.4.3 PVC Crest Pad Pipe

Pressure test 414 kPa (70 psi) with gage located in crest pad building.

3.4.4 HDPE Double Contained Pipe

Test with piping in final location. Pressure test single containment piping to 207 kPa (30 psi). Pressure test the carrier pipe of double containment piping to 207 kPa (30 psi) and the containment pipe of double containment piping to 103 kPa (15 psi).

Document and submit the flush, flow rate and flush time.

3.4.4.1 Testing of Piping.

The trench shall be backfilled between joints before testing to prevent movement of pipe. Hydrostatic tests should be made before the joints are covered so that any leaks may be readily detected. Where any section of a pipe is provided with concrete thrust blocking, the hydrostatic tests shall not be made until at least 5 days after installation of the concrete thrust blocking, unless otherwise approved by the CONTRACTOR. If the joints are covered with backfill prior to testing, the SUBCONTRACTOR remains responsible for locating and correcting any leakage in excess of that permitted in Section 3.2.3

The pipeline should be prepared 24 hours prior to testing by filling it with water, in a manner to remove air (piping sections with elevation changes shall be vented in accordance with a fill and venting procedure prior to testing). The test pressure should be applied to stabilize the system. This should minimize losses due to entrapped air, changes in water temperature, distention of

components under pressure, movement of gaskets, and absorption of air by the water and water by the pipe wall.

3.4.4.2 Raw Water HDPE Hydrostatic Test Requirements. Permanent raw water lines installed by the SUBCONTRACTOR to support construction activities shall be tested hydrostatically at 150 psi (10.3 bars) for two hours.

Minimum test procedure is as follows: The water pressure is to be increased in 50-psi (3.4-bar) increments until the test pressure described in the above paragraph is attained. After each increase in pressure, observations are to be made of the stability of the joints. These observations are to include such items as protrusion or extrusion of the gasket, leakage, or other factors likely to affect the continued use of a pipe in service. During the test, the pressure is not to be increased by the next increment until the joint has become stable. This applies particularly to movement of the gasket. After the pressure has been increased to the required test value and held for one hour, the pressure is to be decreased to 0 psi while observations are made for leakage. The pressure is again to be slowly increased to the value specified in the above paragraph and held for one more hour while observations are made for leakage and the leakage measurement is made.

The amount of leakage in buried piping shall be measured at the specified test pressure by pumping from a calibrated container. For new pipe, the amount of leakage at the joints shall not exceed two quarts per hour (1.89 L/h) per 100 gaskets or joints irrespective of pipe diameter. No visible leakage shall be allowed in aboveground piping.

The amount of allowable leakage specified in the paragraph above shall be permitted to be increased by one fluid ounce per inch valve diameter per hour (30 ml/25 mm/h) for each metal seated valve isolating the test section.

Tests shall be made by the SUBCONTRACTOR in the presence of the CONTRACTOR. The certificate shown in NFPA 24 Figure A-9-2.1 shall be completed by SUBCONTRACTOR.

Additives, corrosive chemicals such as sodium silicate, brine, or other chemicals shall not be used while hydrostatically testing systems or for stopping leaks.

3.5 PNEUMATIC TESTING

The SUBCONTRACTOR shall perform acceptance testing of stainless steel piping. Where the pipes will be covered with liner, gravel, soil, etc., the SUBCONTRACTOR shall complete the required testing and receive approval by the CONTRACTOR prior to burying the pipe or covering the pipe.

Testing procedures shall be submitted.

CONTRACTOR shall be notified of pneumatic testing. CONTRACTOR or others shall witness pneumatic tests. Failure to notify the CONTRACTOR 24 hours, prior to testing, may cause the SUBCONTRACTOR to postpone or perform the test again.

3.5.1 General

Provide test equipment and materials, including compressor, gages, and other equipment required. Pressure gages used shall be graduated in increments not greater than 6.9 kPa (1 psi) and shall have range of approximately twice test pressure. Use only calibrated gages and instruments. Provide calibration certificates traceable to NTS. Gage serial numbers shall be traceable to tests performed. Specify the allowable tolerance for testing pressures.

Test in accordance with applicable provisions of ASME B31.3, as modified by the requirements of this section.

Only non-toxic, nonflammable, inert gases or air shall be used.

Pressurize the pipeline system to 69 kPa (10 psi). Hold test pressure for four hours. Test time will be accrued only while full test pressure is applied to system.

During testing, remove from systems any equipment that would be damaged by test pressure. Replace removed equipment after testing.

Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system. Test records shall include marked-up drawings indicating which piping was tested.

Where new pipe connects to existing piping, the joint between the two pipes shall be tested. Correct leaks by repairing joints; makeshift remedies will not be permitted.

The SUBCONTRACTOR shall be responsible for providing temporary fillings, plugs, and thrust blocking for testing at the specified pressure.

The measured pressure loss shall be no more than 5% for the piping at the specified test pressure throughout the specified duration.

3.5.2 Pressure Relief Valve

During pneumatic testing, a pressure relief device shall be provided for each piping section being tested. The device shall have a set pressure not higher than the test pressure plus the lesser of 10 percent of the test pressure or 350 kPa (50.8 psi).

3.6 CLEANING

Clean all piping as required to remove foreign materials including dirt, grease, shavings, and other matter. Debris and surplus materials resulting from work, as a result of this installation effort, shall be removed.

3.7 WIRE ROPE SYSTEM INSTALLATION

3.7.1 Work Plan

The SUBCONTRACTOR shall submit a work plan, which will indicate how the wire rope will be installed. Additionally, the work plan shall describe the procedure how the wire rope shall be attached and removed from the termination sockets to prevent the cable from falling into the pipe.

3.7.2 Unloading and Inspection

Upon delivery to the SUBCONTRACTOR'S work or storage area, the wire ropes shall be inspected in the presence of the CONTRACTOR. In particular, the wire rope shall be inspected for dings, kinks or other damage. The wire ropes shall be reeled from spool to spool in order to allow complete inspection of the wire ropes over their entire length. The SUBCONTRACTOR shall perform the unreeling/reeling operation, and furnish extra spools or any other equipment required. Upon completion of the inspection, the SUBCONTRACTOR shall furnish the CONTRACTOR with a written report of the results.

3.8 QUALITY ASSURANCE/QUALITY CONTROL

Construction Quality Control and Testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR, or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the filing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall maintain and supply to CONTRACTOR records of his quality control for operations including but not limited to the following:

- (1) Delivery, storage, and handling of devices and equipment used.
- (2) Conformance of materials to the requirements of this specification.
- (3) Inspection of devices and equipment installed

- (4) Field testing of devices and equipment.
- (5) Installation of devices and equipment to these requirements and applicable codes and standards.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the CONTRACTOR within 1 working day following the inspection or test.

SPECIFICATION FOR

DOCUMENT CONTROL *mjp 10/11/07*

TECHNICAL SPECIFICATION

FOR

LEACHATE PUMPS

ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)

CELLS 7, 8, 9 & 10 CONSTRUCTION

WASHINGTON CLOSURE HANFORD		JOB NO. 14655
SUPPLIER/SUBCONTRACTOR DOCUMENT STATUS STAMP		
1. <input checked="" type="checkbox"/> Work may proceed. 2. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission. 3. <input type="checkbox"/> Revise and resubmit. Work may proceed prior to resubmission subject to resolution of indicated comments. 4. <input type="checkbox"/> Revise and resubmit. Work may not proceed. 5. <input type="checkbox"/> Permission to proceed not required.		
Permission to proceed does not constitute acceptance or approval of design details, calculations, analyses, test methods, or materials developed or selected by the supplier/subcontractor and does not relieve supplier/subcontractor from full compliance with contractual obligations or release any "holds" placed on the contract.		
CHECK REVIEW REQUIREMENT	REVIEWED BY	DATE
SPECIAL ELECTRICAL MECHANICAL PIPING CIVIL ENVIRONMENTAL WASTE SAFETY MATERIAL PROTECTION IS HOODS FIELD OTHER	<input checked="" type="checkbox"/> ENVIRONMENTAL <input type="checkbox"/> ELECTRICAL <input type="checkbox"/> MECHANICAL <input type="checkbox"/> PIPING <input type="checkbox"/> CIVIL <input type="checkbox"/> ENVIRONMENTAL <input type="checkbox"/> WASTE <input type="checkbox"/> SAFETY <input type="checkbox"/> MATERIAL <input type="checkbox"/> PROTECTION <input type="checkbox"/> IS <input type="checkbox"/> HOODS <input type="checkbox"/> FIELD <input type="checkbox"/> OTHER	<i>10/9/07</i>
REVIEWED BY: <i>Bill Borlaug</i> Project Engineer		DATE: <i>10/9/07</i>
DOCUMENT ID NUMBER: <i>0600X-SC-G0524 05-18 013</i>		SUBMITTAL: <i>013</i>
SCIPD. No.	SSRS ITEM	SUBMITTAL



EXPIRES 11-22-08

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Rev	Date	Reason for Revision	Originator	Checker	Project Engineer	LEAD Design Eng.
0	<i>9-27-07</i>	Issued for Construction	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
Washington Closure Hanford, LLC		RIVER CORRIDOR CLOSURE CONTRACT	Job No. 14655 Specification No. 0600X-SP-M0030 Page 1 of 9	RECEIVED OCT 09 2007 WCH - DOCUMENT CONTROL		

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LEACHATE PUMPS

1.0 GENERAL

1.1 SUMMARY

This specification establishes quality and workmanship requirements and defines how quality is measured for Equipment.

1.2 ABBREVIATIONS

The abbreviations listed below, when used in this specification, have the following meaning:

ANSI	American National Standards Institute
ERDF	Environmental Restoration Disposal Facility
HDPE	High Density Polyethylene
HI	Hydraulic Institute
NEMA	National Electrical Manufacturers Association
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Plan
SSRS	Subcontractor/Supplier Submittal Requirements Summary

1.3 CODES, STANDARDS, LAWS, AND REGULATIONS

Unless otherwise approved or shown, the following Codes, Standards, Laws, and Regulations of the latest issue, at the time of bid, shall apply to establish the minimum requirements for Equipment. Referenced test methods, specifications, and recommended practices are to be used to verify material properties and to identify acceptable practices applicable to Equipment. Failure to identify applicable codes and standards does not imply elimination of required knowledge and compliance to perform work.

HI-01	Hydraulic Institute Standards for Centrifugal, Rotary & Reciprocating Pumps
NEMA MG 1	Motors and Generators

1.4 GENERAL REQUIREMENTS

1.4.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate equipment that has been in satisfactory operation at least 5 years prior to bid opening. Pumps and motors of the same types shall each be the product of one manufacturer.

1.4.2 Description

The pumps shall be of the types indicated and specified. The single driving units for the pumps shall be electric motors as indicated and specified.

1.4.3 Nameplates

Pumps and motors shall have a stainless steel nameplate securely affixed (attaching hardware to be stainless steel also) in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, catalog number and equipment tag number. In addition, the nameplate for each pump shall show the pump identification number, capacity in gpm at rated speed in rpm, and head in feet of water. Nameplate for each electric motor shall show at least the minimum information required by 10.38 NEMA MG 1.

1.4.4 Electrical Work

Electrical motor driven equipment specified herein shall be provided complete with motors, motor starters, and controls. Electric equipment and wiring shall be in accordance with the Technical Specification for ELECTRICAL WORK. Electrical characteristics shall be as indicated. Motor starters shall be provided complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual and automatic controls and protective/ signal devices required for the operation and any control wiring required for controls and devices but not shown on electrical plans shall be provided under this section of the specifications.

1.4.5 Selection Criteria

Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. Pumps shall be selected at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency.

1.4.6 Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services, shall be attached thereto.

1.4.7 Verification of Dimensions

The SUBCONTRACTOR shall verify dimensions in the field and shall advise the CONTRACTOR of any discrepancy before performing the work.

1.4.8 Factory Tests

The manufacturer or a nationally recognized testing agency shall test each pump in compliance with ANSI/HIS 11.6, Level B. Certified test results shall be submitted to the CONTRACTOR.

1.5 TECHNICAL SUBMITTALS

Submittals stated herein or elsewhere in the specification shall be submitted for review and approval in accordance with Exhibit "F", Subcontractor/Supplier Submittal Requirements Summary (SSRS). Submittals that do not meet requirements will be rejected. Rejected submittals shall be resubmitted to avoid delays.

1.5.1 Materials and Equipment

Manufacturer's descriptive data and technical literature, performance charts and curves for impeller sizes for a given casing, catalog cuts, and installation instructions, spare parts data for each different item of material and equipment specified, after approval of the detail drawings will be submitted not later than 75% of construction completion date. Data shall include a complete list of parts and supplies, with current unit prices and source of supply.

1.5.2 Pump Systems

Submit a complete listing of equipment and materials. Drawings shall contain complete "as-built" wiring and schematic diagrams and any other details required demonstrating that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

1.5.3 Tests

Test reports in booklet form showing field tests performed to adjust each component and field tests performed to prove compliance with the specified performance and operating criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

1.5.4 Operation and Maintenance Manuals

Six complete sets of instructions containing the manufacturer's operating and maintenance instructions for each piece of equipment. The manuals shall be submitted not later than at the 75 percent of construction completion date. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the building, name of the SUBCONTRACTOR, and Subcontract number. Flysheets shall be placed before instructions covering each subject. Instruction sheets shall be approximately 216 mm by 278 mm (8-1/2 by 11 in.), with large sheets of drawings folded in. Instructions shall include, but not be limited to the following:

- a. As-built System layout showing piping, valves, and controls.
- b. Approved as-built wiring and control diagrams.
- c. A control sequence describing startup, operation, and shutdown.
- d. Operating and maintenance instructions for each piece of equipment, including lubrication instructions and troubleshooting guide.
- e. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

2.0 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be as specified below and as shown, and shall be suitable for the service intended. Materials and equipment shall be new and unused, except for tests. Where two or more pieces of equipment performing the same function are required, they shall be duplicate products of the same manufacturer.

2.2 SUBMERSIBLE PUMPS

2.2.1 General

- a. The low-capacity submersible pumps in the primary and secondary leachate collection systems of the ERDF trench.
- b. The high-capacity submersible pump in the primary leachate collection system only.
- c. Pumps and motors shall be constructed such that wetted parts (including housing, fasteners, shaft, diffuser chamber, and impellers) are stainless steel, e.g. type 304 or 316 stainless steel, Teflon, and other highly corrosion resistant materials. Gaskets, o-rings, and seals shall have compatibility properties equivalent to viton materials as a minimum.
- d. The pump and motor shall have bearings that permit the pump to be operated in continuous or intermittent service in the horizontal position. The pump shaft shall be type 304, 316, or 17-4 stainless steel and rotate on bearings that are product-lubricated.

- e. The external portions of the case shall be free of sharp edges or burrs which would damage the HDPE slope riser pipes, or which might prevent the free travel of the pump along the enclosing pipe.
- f. The pumps shall be permanently mounted on factory-installed wheeled trolley assemblies to facilitate placement and removal from the riser pipes. Trolley assemblies shall be free of sharp edges or burrs.
- g. Each pump shall be fitted with a stainless steel lifting cable of sufficient strength to install and remove the pump unit, discharge line, power cable, and any other associated equipment.
- h. Each pump shall have check valve removed or hole drilled into check valve to allow water to drain from discharge piping.
- i. The motors shall be submersible, hermetically sealed (suitable for continuous horizontal submerged service), and constructed of 316 stainless steel. Motors shall be wired to run on three phase, 480 Volt, 60 Hz service.
- j. Pumps shall be commercially available units from a manufacturer normally engaged in the production of leachate removal pumps for horizontal installations through side slope riser pipes.
- k. The low-capacity submersible pumps shall be capable of draining the sump to the lowest level possible, but in any case shall drain to less than 1 foot. The high capacity submersible pumps shall be capable of draining the sump to less than 1.4 feet.
- l. Pumps shall be equivalent to centrifugal submersible SurePump Wheeled Sump Drainers as manufactured by EPG Companies, Inc. or as approved by CONTRACTOR.

2.2.2 Low-Capacity Submersible Pumps

- a. The low-capacity submersible pumps for both primary and secondary leachate collection systems shall be identical.
- b. The low capacity submersible pumps shall be rated approximately as follows:

RATED CAPACITY: 15 gpm
TOTAL DYNAMIC HEAD: 140 feet

c. Schedule:

Cell	Pump No	Description
7	2-P-27	Primary Sump
7	2-P-28	Secondary Sump
8	2-P-30	Primary Sump
8	2-P-31	Secondary Sump
9	2-P-33	Primary Sump
9	2-P-34	Secondary Sump
10	2-P-36	Primary Sump
10	2-P-37	Secondary Sump

2.2.3 High-Capacity Submersible Pump

a. The high-capacity submersible pump shall be rated approximately as follows:

RATED CAPACITY	140 gpm
TOTAL DYNAMIC HEAD	130 feet

b. Schedule:

Cell	Pump No	Description
7	2-P-26	Primary Sump
8	2-P-29	Primary Sump
9	2-P-32	Primary Sump
10	2-P-35	Primary Sump

3.0 EXECUTION

3.1 INSTALLATION

Each pump shall be installed in accordance with the written instructions of the manufacturer.

3.2 LABELS AND TAGS

Label and tag valves, indicators, piping, disconnects, equipment, switches etc., per the specifications and associated drawings.

3.3 TESTS

After installation of the pumping units and appurtenances is complete, operating tests shall be carried out to assure that the pumping installation operates properly. Each installed pumping unit shall be given a running field test in the presence of the CONTRACTOR for a minimum of 2 hours. Each pumping unit shall be operated at its rated capacity or such other point on its head-capacity curve selected by the CONTRACTOR. The SUBCONTRACTOR shall provide

an accurate and acceptable method of measuring the discharge flow. Tests shall assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that manual and automatic controls function properly. If any deficiencies are revealed during any tests, such deficiencies shall be corrected and the tests shall be reconducted.

3.4 DEMONSTRATION

Upon completion of the work and at a time designated by the CONTRACTOR, the services of one or more competent engineers shall be provided by the SUBCONTRACTOR for a period of not less than 4 hours to instruct a representative of the CONTRACTOR and the ERDF Disposal Subcontractor in the operation and maintenance of equipment furnished under this section of the specifications.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

Construction Quality Control and testing requirements are provided in Construction Quality Requirements, Specification No. 0600X-SP-G0037.

At locations where the field testing conducted by either the SUBCONTRACTOR, CONTRACTOR, or CQA Subcontractor indicates that conditions are outside the acceptable limits of the specifications, the failing area shall be reworked or removed and replaced. These areas shall be retested and the repair process repeated as necessary until passing results are achieved.

The SUBCONTRACTOR shall maintain and supply to CONTRACTOR records of his quality control for operations including but not limited to the following:

- 1) Delivery, storage, and handling of devices and equipment used.
- 2) Conformance of materials to the requirements of these specifications.
- 3) Inspection of devices and equipment installed
- 4) Field testing of devices and equipment.
- 5) Installation of devices and equipment to these requirements and applicable codes and standards.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the CONTRACTOR within 1 working day following the inspection or test.