Appendix 4D **Construction Specifications (C-1)**
RPP-18489, Rev. 1

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DIVISION 1–GENERAL REQUIREMENTS

DIVISION 2–SITE CONSTRUCTION

SECTION 02200 – SITE PREPARATION Sched. A & B

PART 1 – GENERAL

Work included:

This section describes requirements for clearing, grubbing and stripping of the IDF project area and associated facilities.

DEFINITIONS:

Interfering or Objectionable Material: Trash, rubbish, and junk.

Clearing: Removal of existing vegetation and interfering or objectionable material lying on or protruding above ground surface.

Grubbing: Removal of vegetation and other organic matter including sagebrush, stumps, buried logs, and roots greater than 2 inches caliper to a depth of 6 inches below subgrade.

Stripping: Removal of topsoil and other organic matter. Strippings suitable for topsoil shall be limited to upper 6 inches.

Project Limits: Areas actually needed for site improvements, stockpiles, and borrow areas, as shown or specified, within which Work is to be performed.

RAW WATER SUPPLY:

Depending on the availability of connections to the raw water pipeline system, water for dust control may be obtained either from an existing water fill station on 4th Street near the west exit of the 200 East Area or from the raw water line that crosses the IDF site. A new raw water pipeline is being installed as part of Schedule A of the IDF project.

Whether water is obtained from the existing water fill station or from new facilities on the IDF site, use of connections to the raw water system shall be in accordance with guidance from the Hanford Site Water Purveyor. Use and discharge of raw water during construction for construction activities, including dust control and fire protection, shall be controlled through the Hanford Site Water Purveyor, and shall comply with WAC 173-200 and the State Waste Discharge Permit No. ST 4508. For any use of existing water fill station or a water connection on the IDF site, the total of all IDF project water usage from the raw water system shall not exceed 1,500 gpm. There is no guarantee that the 1,500 gpm will be available at all times or that will be available from a single location on the IDF water system. In addition, the maximum water use limitation may be periodically reduced by the Hanford Site Water Purveyor depending on the other Hanford site demands on the raw water system and/or the availability of raw water pumping capacity within the Hanford raw water system. When using any connection to the raw water system, the Construction General Contractor shall take whatever means are necessary to operate fill stations and other connections in such a manner to prevent causing water hammer. If water usage from the system is found to cause water hammer, the Hanford Site Water Purveyor may require the use of orifice plates, changes to valve operation methods, and/or a reduction in water use at a water connection as necessary to eliminate the water hammer. For any onsite fill station, Construction General Contractor shall provide a water storage tank (minimum size 20,000 gallons) equipped with a float actuated fill valve to minimize demand surges on the Hanford Water Supply.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Site Preparation Plan: Prior to any mobilization of equipment to the site, the Construction General Contractor shall submit a Site Preparation Plan for approval. This plan shall include the following information as a minimum:

Detailed description of the proposed method for clearing, grubbing, and stripping the site. The plan shall identify those areas of the project site, which will be cleared, grubbed, and stripped. In addition, it will identify staging areas, stockpile areas, and the sequence in which the site preparation will be executed.

Dust Control Plan: Prior to any earthwork activities on the project site such as site preparation and excavation, Construction General Contractor shall submit a Dust Control Plan for approval. The plan shall identify methods and equipment to minimize/control dust generation during all earthwork operations and include the following minimum requirements:

Continuous control of dust generation during excavation and backfill placement, etc.

Continuous control of wind-generated dust, including disturbed areas that are not being actively worked.

Keep haul roads watered to control dust.

A minimum two full water trucks (5,000 gallons each) for the duration of the project.

Apply water or other approved dust suppressants as minimum to keep visible dust to a minimum during execution of Work.

Appropriate hand-held hose lines, sprinklers, and other equipment as needed to access and control non-vehicle access areas such as borrow and stockpile side slopes.

Maintain and protect native cover where possible, through minimization of site disturbance.

Limit access road development to minimum necessary to execute work.

Stabilization of inactive disturbed work areas by longer-term methods such as matting, tack and mulch or crusting agents.

Implementation of permanent stabilization on a regular basis when sufficient area exists for application or as needed to control dust.

General Construction Contractor shall use daily field reports to document dust control measures implemented and their effectiveness.

These dust control plan items are required to satisfy the requirements of Section 3.0 - Mitigation of Potential Dust Impacts from Construction Activities of the "Mitigation Action Plan for USDOE, Hanford Site, Immobilized Low-Activity Waste (ILAW) Disposal Site Construction (Project W-520)," prepared by PNNL for USDOE.

Submit details of raw water supply, storage, and water withdrawal limiting equipment as part of the Dust Control Plan.

SCHEDULING AND SEQUENCING:

The sequence of the activities listed below shall be followed by the Construction General Contractor for the site preparation work.

Initial site preparation activities shall commence only after Dust Control Plan and Site Preparation Plan have been approved.

Following the approved Site Preparation Plan, establish an adequate water supply source for dust control use.

After establishing an adequate water supply and sediment controls, proceed with site preparation activities as specified.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

GENERAL:

Clear, grub, and strip only areas actually needed for stockpiles, borrow, or site improvements within limits shown and specified.

Extent of Site Preparation required for individual designated stockpile areas shall be as directed by the Construction Manager.

Do not injure or deface vegetation that does not require removal.

As an initial step in clearing the site, the General Construction Contractor shall remove all trash, rubbish, and junk from the site. This material shall be disposed in accordance with Division 1 requirements.

CLEARING:

Cut off shrubs, brush, weeds, and grasses to within 4 inches of ground surface.

GRUBBING:

Grub all areas where excavations, fill, roadways, structures, and ditches are to be placed.

Vegetation other than noxious weeds, removed by the clearing and grubbing, shall be placed in stockpile with the strippings to be used as topsoil. Place vegetation at the base of the strippings stockpile area and track with equipment to break apart and crush the material. Obtain Construction Manager approval of the vegetation placement.

STRIPPING:

Strip all areas where excavations, borrow areas, stockpiles, fills, roadways, structures, and ditches are to be placed, to remove organic materials. Do not remove subsoil with topsoil.

Stockpile strippings from the upper 6 inches below ground surface after clearing and grubbing, meeting requirements for topsoil in Section 02920, RECLAMATION AND REVEGETATION, separately from other excavated material at either the designated stockpile area location shown on the Drawings, or other areas as approved by the Construction Manager.

IDF RAW WATER CONNECTIONS:

General Construction Contractor shall take necessary steps to prevent freezing and/or damage to the IDF raw water system connections.

DISPOSAL:

Clearing and Grubbing Debris: Bury vegetation that is not suitable for topsoil at a designated area as directed by the Construction Manager. Disposal of the remaining interfering or objectionable material shall be in accordance with Division 1 requirements.

Strippings: Dispose of strippings that are unsuitable for topsoil as specified above for clearing and grubbing debris.

Burning Prohibited: No burning of any materials generated during the site preparation work will be allowed at the site.

END OF SECTION 02200

SECTION 02315 – FILL AND BACKFILL Sched. A & B

PART 1 – GENERAL

WORK INCLUDED:

This section describes placement and testing of fill and backfill in general areas of the site (including stockpiles).

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

DEFINITIONS:

Relative Compaction:

Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.

Apply corrections for oversize material to maximum dry density.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

Completed Course: A course or layer that is ready for next layer or next phase of Work.

Lift: Loose (uncompacted) layer of material.

Geosynthetics: Geotextiles, geocomposites, geosynthetic clay liner, or geomembranes.

Well-Graded:

A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.

Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1-foot outside outermost edge at base of foundations or slabs.
1-foot outside outermost edge at surface of roadways or shoulder.
0.5-foot outside exterior at spring line of pipes or culverts.

Imported Material: Materials obtained from sources offsite, suitable for specified use.

Standard Specifications: When referenced in this section, shall mean Standard Specifications for Road, Bridge, and Municipal Construction, as published by the Washington State Department of Transportation, 2002 edition, English units.

SLDS: Secondary Leak Detection System.

Permanent Stockpile: Stockpile of material that remains at the completion of construction.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials from independent testing laboratory as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

Stockpile Plan: Prior to any excavation activities associated with construction of the IDF, Construction General Contractor shall submit a Stockpile Plan for approval. The plan shall include the following information:

Scale drawing, using the project plans as a base, which shows the proposed location for stockpiles on the project site. Show all access roads around stockpiles. Address stockpile locations during construction of the IDF and permanent stockpiles, which will remain upon completion of construction activities for this project.

Stockpile layout drawings, which show the estimated location of toe of slope and top of slope for each stockpile. Drawings shall show plan and typical sections and shall be fully dimensioned.

Plan shall show how differing materials encountered during the excavation will be segregated for future use. This includes material for use as topsoil, admix base soil, and operations layer. Also, show a stockpile area for material to be used in the future as clean backfill during landfill operations by the Tank Farm Contractor.

Method by which stockpile compaction will be achieved.

Dust control for the stockpiles during active use and until grass is established.

Placing of topsoil, seeding, fertilizing, and mulching each stockpile after active use of stockpile is finished in accordance with Section 02920, RECLAMATION AND REVEGETATION.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Qualifications of independent testing laboratory.
Qualifications of construction quality control personnel.
Construction quality control test reports

SEQUENCING AND SCHEDULING:

Complete applicable Work specified in Sections 02316, EXCAVATION, and 02319, SUBGRADE PREPARATION, prior to placing fill or backfill.

PERMIT REQUIREMENTS:

A backfill and fill permit is required for each backfill and fill work element. Construction General Contractor shall obtain from Tank Farm Contractor and post before starting backfill and fill work, as specified in Division 1, General Requirements.

CONSTRUCTION QUALITY ASSURANCE:

The Construction General Contractor shall accommodate all CQA activities described herein and in the CPA Plan for this project. The CQA Plan is made part of these Specifications by reference.

The CQA Certifying Engineer shall determine in-place density and moisture content by any one or combination of the following methods: ASTM D2922, ASTM D3017, ASTM D1556, ASTM D2216, or other methods approved by the Construction Manager.

Testing requirements and locations will be determined by the CQA Certifying Engineer. Construction General Contractor shall cooperate with the CQA Certifying Engineer and testing work by leveling small test areas designated by the CQA Certifying Engineer. Backfill test areas at Construction General Contractor's sole expense. The CQA Certifying Engineer may have any material tested at any time, location, or elevation.

After Construction General Contractor makes repairs to any areas failing a test, the Construction General Contractor shall rerun appropriate tests, subject to the approval of the CQA Certifying Engineer, to demonstrate the area meets specifications, at the Construction General Contractor's sole expense.

The following minimum test schedule shall be assumed. Additional tests may be required as directed by CQA Certifying Engineer.

In-place density tests shall be made on the following minimum schedule:

Earth fill: One per 5,000 square feet (ft^2) per lift.

Structural Fill: One per 2,500 ft^2 per lift.

Subgrade Preparation: Four per acre.

Operations Layer (Outside Edge of Liner): One per 5,000 ft^2 per lift.

Operations Layer Material (SLDS): Two (2) per lift.

Standard Proctor (ASTM D698) laboratory density curves (five-point minimum) shall be performed for each material by the CQA Certifying Engineer. Samples of native materials used for embankment and backfill and samples of imported materials shall be taken at locations as specified by CQA Certifying Engineer.

Gradation tests (sieve analysis) shall be performed in accordance with ASTM D422 on operations layer material obtained from required excavations to demonstrate the materials meet the Specifications. Samples of operations layer material shall be taken from each 10,000 cubic yards of placed material in accordance with ASTM D75.

PART 2 – PRODUCTS

EARTHFILL:

Excavated material from required excavations and designated borrow sites, free from rocks larger than 4 inches in the greatest dimension, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

STRUCTURAL FILL:

Structural fill adjacent to concrete structures shall be as specified in Section 02320, TRENCH BACKFILL, for Pipe Bedding. Structural fill beneath concrete structures and beneath leachate storage

tank shall conform to the requirements of Section 9-03 9(3) Crushed Surfacing-Top Course in the Standard Specifications.

OPERATIONS LAYER:

Meeting the requirements of earthfill above and having a maximum of 25 percent by weight passing the No. 200 U.S. sieve and a maximum particle size of 2 inches.

DRAIN GRAVEL:

Material for drain gravel shall conform to the requirements of Section 9-03.12(4) of the Standard Specifications except material shall be subrounded to rounded gravel. Crushed rock and angular gravel shall not be allowed.

CRUSHED SURFACING:

Material for crushed surfacing-base course and top course shall conform to the requirements in Section 9-03 9(3) of the Standard Specifications.

QUARRY SPALLS:

Quarry spalls shall consist of broken stone free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather and shall meet the following requirements for grading:

Maximum Size: 8 inches
50 percent by weight shall be larger than 3 inches
Minimum Size: 3/4 inch

SOURCE QUALITY CONTROL:

Gradation tests performed in accordance with ASTM D422 by a qualified independent testing laboratory shall be made for imported materials on samples taken at place of production prior to shipment. Imported materials shall not be shipped without submittal approval. Samples of the finished product for gradation testing shall be taken from each 2,000 tons of prepared materials in accordance with ASTM D75. Test results shall be submitted to Construction Manager within 48 hours after sampling. Size distribution for imported quarry spalls material shall be determined in accordance with one of the methods described in ASTM D5519.

BASE SOIL:

As specified in Section 02666, ADMIX LINER.

WATER FOR MOISTURE CONDITIONING:

See Section 02200, SITE PREPARATION, for raw water supply availability and requirements for proper compaction.

PART 3 – EXECUTION

GENERAL:

Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

Place and spread fill and backfill materials in horizontal lifts of uniform thickness as specified in paragraphs BACKFILL UNDER AND AROUND STRUCTURES and FILL, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

Tolerances:

Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.

Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

BACKFILL UNDER AND AROUND STRUCTURES:

Under Facilities: Backfill with earthfill or structural fill, as shown on the Drawings, for each structure or facility. Place earthfill or structural fill in lifts of 6-inch maximum compacted thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698.

FILL:

Outside Influence Areas Beneath Structures, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

Allow for 6-inch thickness of topsoil where required.
Maximum 8-inch thick lifts.
Place and compact fill across full width of embankment.
Compact to minimum 95 percent relative compaction.

REPLACING OVEREXCAVATED MATERIAL:

Replace excavation carried below grade lines shown as follows:

Beneath IDF Cell: Earthfill as specified herein.

Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

Beneath Structures and Roadways: Structural fill or earthfill as shown on the Drawings and specified herein.

TOPSOIL:

Place topsoil on areas disturbed by construction and on permanent stockpile slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

STOCKPILING:

Material shall be placed in permanent stockpiles as follows:

Place material in maximum 3-foot lifts and compact with a minimum four passes with earth-moving equipment. Uniformly route hauls truck traffic across the surface of each lift to aid in lift compaction.

Maximum slopes shall be 3H:1V. Minimum slopes shall be 3 percent to promote drainage.

Upper 2 feet of stockpile surface shall be placed in maximum 12-inch thick lifts and compacted to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

Place 6-inch thick layer of topsoil on completed slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Permanent stockpiles shall be seeded, fertilized, and mulched when each stockpile is completed and as directed by the Engineer in accordance with Section 02920, RECLAMATION AND REVEGETATION.

PLACING CRUSHED SURFACING:

Place crushed surfacing base course and top course at locations shown on the Drawings. Placement shall conform to Section 4-04.3 of the Standard Specifications.

Thickness of the drain gravel on the cell floor shall be a minimum of 1.0 foot (increase drain gravel thickness in vicinity of LCRS collection and riser pipes as shown on drawings) and tolerances for the top of the drain gravel shall be grade to plus 0.2 foot.

pLacing DRAIN GRAVEL and operations layer over geosynthetics:

Place material over geosynthetics as specified in Sections 02371, GEOTEXTILES; 02661, GEOMEMBRANES; and 02667, GEOSYNTHETIC CLAY LINER (GCL).

Compaction requirements for drain gravel on the cell floor, around pipes, and the sumps are specified in Section 02320, TRENCH BACKFILL.

Operations layer within lining system limits, except as specified for SLDS sump area, shall be placed in 12-inch thick lifts and track-walked into place with a minimum two passes with a Caterpillar D6M-LGP or equal. Operations layer material within SLDS sump area shall be placed in 12-inch thick lifts and compacted to 90 percent relative compaction. Operations layer placed outside edge of liner, such as for shine berm, shall be placed in maximum 8-inch thick lifts and compacted to 95 percent relative compaction.

Place material to the lines and grades shown and compact by tracking a minimum two passes with spreading equipment. Thickness of the operations layer shall be a minimum 3 feet and tolerances for top of operations layer shall be grade to plus 0.3 foot.

QUARRY SPALLS PLACEMENT:

Quarry spalls shall be placed around the ends of stormwater pipes to provide erosion protection in accordance with the Plans and as directed by the Engineer. Quarry spalls shall be placed in such a manner that all relatively large stones are essentially in contact with each other and voids are filled with the finer materials to provide a well graded compact mass. Finished surface shall be free from irregularities. The stone shall be dumped on the ground in a manner that will ensure the stone attains its specified thickness in one operation. When dumping or placing, care shall be used to avoid damaging the underlying material. Stone shall not be dumped from height greater than 12 inches above surface. Material placement shall be started from the bottom of the installation, working toward edges. Geotextile damaged during the placement of quarry spalls shall be repaired at Construction General Contractor's sole expense.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform in-place density and moisture content tests with own qualified personnel or with a qualified independent testing laboratory as specified in paragraph CONSTRUCTION QUALITY ASSURANCE, to be observed by the Construction Manager, on the following minimum schedule:

Material Placed by Stockpile (Upper 2 Feet): One per 10,000 ft^2 per lift.

Construction General Contractor shall submit qualifications of personnel or independent testing laboratory that will perform construction quality control.

END OF SECTION 02315

SECTION 02316 – EXCAVATION Sched. A & B

PART 1 – GENERAL

WORK INCLUDED:

This section describes all excavation necessary for completion of the Project, including excavation for structures, pipe trenches, and leachate sumps.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926 OSHA Safety and Health Regulations for Construction; Subpart P – Excavations

EXCAVATION SUPPORT AND SAFETY:

Install and maintain adequate excavation safety and shoring systems that meet the requirements of OSHA (29 CFR 1926 Subpart P) and Washington Industrial Safety and Health Act, Chapter 49.17 RCW and WAC 296-155, "Safety Standards for Construction Work" Part IV-Excavation, Trenching and Shoring, and all other applicable local, state, and federal regulations.

Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work. Per OSHA requirements, 29 CFR 1926.652 requires that custom shoring installations shall be designed and stamped by a professional engineer licensed in the State of Washington.

WEATHER LIMITATIONS:

Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PERMIT REQUIREMENTS:

An excavation permit is required for each excavation work element. Construction General Contractor shall obtain from Tank Farm Contractor and post before starting excavation work, as specified in Division 1, General Requirements.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

GENERAL:

Generally, excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate subgrade to within tolerance of minus 0.5 foot to plus 0.1 foot except where dimensions or grades are shown or specified as maximum or minimum.

If unexpected, debris foreign material of any kind (e.g., contaminated soil) or cultured properties (e.g., bones and artifacts) is exposed or encountered during excavation, the Construction General Contractor shall stop work in the affected area and notify the Construction Manager. Obtain approval from Construction Manager before resuming excavation.

Control dust from excavation activities as specified in approved Dust Control Plan. See Section 02200, SITE PREPARATION, for Dust Control Plan requirements.

If soft or loose subgrade zones are encountered at the bottom of the excavation after proof rolling, correct as specified in Section 02319, SUBGRADE PREPARATION.

STRUCTURE EXCAVATION:

Excavations for such structures as footings, foundations, slabs, and manholes shall be made to the depths shown on the Drawings and of sufficient width to allow adequate room for placement of structural fill setting and removing forms, installing accessories and inspection. Care shall be taken to prevent disturbing the bottom of the excavation. Excavation to final grade shall not be made until just before concrete forms are to be placed therein. Prepare bottom of structure excavation as specified in Section 02319, SUBGRADE PREPARATION, prior to placement of concrete foundations.

TRENCH AND SUMP EXCAVATION:

Trenches and sumps shall be of sufficient width to provide adequate room for workmen to perform any necessary service to the materials or items being installed therein and to permit proper compaction of the backfill.

Minimum Width of Trenches: As shown on Drawings.

Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

If wet or otherwise unsatisfactory soil is encountered in a trench excavation, at or below the trench bottom, it shall be brought to the attention of the Construction Manager and removed as directed. The bottom of the excavation shall then be brought to the required grade with stabilization as specified in Section 02320, TRENCH BACKFILL.

TEMPORARY STOCKPILE EXCAVATION:

Always keep stockpile neat and orderly and work there in a systematic manner. Take necessary precautions to maintain existing erosion control measures and prevent offsite sediment releases.

When work is completed in the stockpile area, grade area to drain surface water runoff to appropriate collection and discharge points. Reclaim disturbed areas of stockpile as specified in Sections 02315, FILL AND BACKFILL, and 02920, RECLAMATION AND REVEGETATION.

STOCKPILING EXCAVATED MATERIAL:

Stockpile excavated material that is suitable for use as embankment or backfill, as operations layer material, road gravel, or drain gravel, until material is needed. Place materials in stockpiles at the designated locations shown on the Drawings. Materials shall be placed in stockpiles as specified in Section 02315, FILL AND BACKFILL.

Confine stockpiles to within areas shown on Drawings. Do not obstruct roads or streets. Stockpiles should maintain clearance from existing permanent monitoring wells and disposed cribs as shown on the Drawings.

Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads. The registered professional engineer responsible for the shoring design shall approve stockpile locations.

Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement. The registered professional engineer responsible for the shoring design shall approve stockpile locations.

DISPOSAL OF SPOIL:

Dispose of excavated materials, which are unsuitable or not needed for fill or backfill, in designated stockpile areas shown on the Drawings, or spoil disposal areas as directed by Construction Manager. Materials shall be placed as specified in Section 02315, FILL AND BACKFILL.

TRENCH EXCAVATION FOR GEOSYNTHETIC ANCHOR TRENCHES:

Geosynthetic anchor trench excavation shall be as specified in Section 02661, GEOMEMBRANES.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor provides adequate survey control to avoid unauthorized over excavation.

END OF SECTION 02316

SECTION 02317 – BORROW AREA EXCAVATION

Sched. B

PART 1 – GENERAL

WORK INCLUDED:

This section describes requirements for borrow excavation from the Admix Base Soil Borrow Area as a source of base soil for the admix. The Admix Base Soil Borrow Area is located within the IDF site boundary approximately 1,000 feet south of the Phase I area as shown on the Drawings.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Borrow Area Development Plan: Detailing development, operation, dust and erosion, mitigation measures, and reclamation of each borrow area.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

GENERAL:

Clear, grub, and strip only areas actually needed for borrow within limits shown or specified.

Do not injure or deface vegetation that does not require removal.

CLEARING, GRUBBING, STRIPPING, AND DISPOSAL:

Clearing, grubbing, and stripping shall meet the requirements of Section 02200, SITE PREPARATION.

DISPOSAL:

Clearing and Grubbing Debris: As specified in Section 02200, SITE PREPARATION.

Strippings: As specified in Section 02200, SITE PREPARATION.

BORROW AREA OPERATION:

Borrow area shall be developed and operated in accordance with the mitigation measures identified in the approved Borrow Area Development Plan and these Specifications.

Always keep borrow pits neat and orderly, and work them in systematic manner. Continuously keep borrow pits graded to drain to a low point, and take necessary precautions to control erosion and prevent offsite sediment releases. Dewater as necessary to develop, operate, and reclaim each borrow area. Control dust as specified in approved Dust Control Plan. See Section 02200, SITE PREPARATION, for Dust Control Plan requirements.

Material meeting the requirements for base soil as specified in Section 02666, ADMIX LINER, shall be excavated from the Borrow Area. Base soil should not be obtained below a depth of 5 feet below existing ground surface (after stripping) without evaluation of the material suitability and authorization from the Construction Manager.

Do not excavate more borrow material than required for Work. Leave surplus material in place.

Excavate material in an orderly manner to avoid inclusion of unacceptable material.

RECLAMATION:

At the completion of borrow area excavation, grade borrow pits to drain to low point so that ponded surface water may be removed by pumping. Where practical, blend graded surfaces neatly with surrounding terrain at completion of borrow operations.

Final Slopes:

Maximum: 4H: 1V.

Minimum: 2 percent.

Do not use borrow pits for disposal, unless otherwise specified or shown.

Place 6-inch thick layer of topsoil and seed, fertilize, and mulch all disturbed areas as specified in Section 02920, RECLAMATION AND REVEGETATION.

END OF SECTION 02317

SECTION 02319 – SUBGRADE PREPARATION Sched. B

PART 1 – GENERAL

work included:

This section describes requirements for preparation of subgrades in areas to receive fill.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

DEFINITIONS:

Optimum Moisture Content: As defined in Section 02315, FILL AND BACKFILL.

Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

Relative Compaction: As defined in Section 02315, FILL AND BACKFILL.

SLDS: Secondary Leak Detection System.

Subgrade: Layer of existing soil after completion of excavation to grade prior to placement of fill, roadway structure, or base for floor slab.

Proof Rolling: Testing of subgrade as specified herein to identify soft or loose zones requiring correction.

SEQUENCING AND SCHEDULING:

Complete applicable Work specified in Section 02316, EXCAVATION, prior to subgrade preparation.

CONSTRUCTION QUALITY ASSURANCE:

The CQA Certifying Engineer shall determine in-place density and moisture for subgrade preparation as specified in Section 02315, FILL AND BACKFILL, except for prepared subgrade for admix on sideslopes.

CQA requirements for geomembrane subgrade preparation are specified in Section 02661, GEOMEMBRANES.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

GENERAL:

Keep subgrade free of water, debris, and foreign matter during compaction or proof rolling.

Bring subgrade to proper grade and cross-section as shown on the Drawings, and uniformly compact surface.

Maintain prepared ground surface in finished condition until next course is placed.

PREPARED SUBGRADE FOR ROADWAY, EMBANKMENT, AND STRUCTURES:

After completion of excavation and prior to foundation, road fill, structural fill, or embankment construction, compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a fully loaded dump truck or equal to detect soft or loose subgrade or unsuitable material.

LANDFILL BOTTOM FLOOR PREPARED SUBGRADE FOR ADMIX LINER:

Prior to admix liner placement, subgrade shall be back bladed to remove loose soil. Low spots or erosion rills shall be backfilled with structural fill as specified herein. Compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a vibratory drum roller or equal to detect soft or loose subgrade or unsuitable material.

LANDFILL SIDESLOPE (3H: 1V) PREPARED SUBGRADE FOR ADMIX LINER:

Prior to admix placement, the subgrade shall be back bladed to remove all loose material produced by trimming operations. Low spots or erosion rills shall be backfilled with structural fill as specified herein. The trimmed surface shall be watered so that moisture penetrates a minimum of 3 inches into the subgrade. The trimmed and watered surface shall be track-walked by D6-LGP dozer or equivalent with a minimum 4 passes to produce a firm and stable subgrade. Visual monitoring (no in-place density testing is required) of the subgrade preparation on sideslopes will be performed by the CQA Certifying Engineer.

PREPARED SUBGRADE FOR GEOMEMBRANE (SECONDARY AND SLDS) AND SECONDARY GCL:

At completion of SLDS excavation and grading (SLDS geomembrane) or admix liner placement (secondary geomembrane and GCL), prepare the subgrade surface for geomembrane or GCL placement. The surface shall not have holes, depressions more than 1 inch in a 12-inch width, nor protrusions extending above the surface more than 1/2 inch. Roll surface with smooth-drum roller to form a firm stable base. Allow for leachate piping and sumps or features as shown on the Drawings.

CORRECTION:

Soft or Loose Subgrade:

Adjust moisture content and compact to meet density requirements, or

Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL.

Unsuitable Material: Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL. Dispose of unsuitable material excavation in accordance with Article DISPOSAL OF SPOIL in Section 02316, EXCAVATION.

END OF SECTION 02319

SECTION 02320 – TRENCH BACKFILL Sched. A & B

PART 1 – GENERAL

WORK INCLUDED:

This section describes requirements for backfilling of trenches for pipe, conduit, and geosynthetics.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

DEFINITIONS:

Pipe Bedding: Granular material upon which pipes, conduits, cables, or duct banks are placed.

Imported Material: Material obtained by the Construction General Contractor from source(s) offsite.

Lift: Loose (uncompacted) layer of material.

Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

SUBMITTALS–APPROVAL NOT REQUIRED:

Vendor Information (VI): Locator ribbon product data.

PART 2 – PRODUCTS

LOCATOR RIBBON:

Ribbon shall be 3 inches wide and shall be red for all electrical conduits, electrical cables, and telephone cables. Blue locator ribbon shall be used for all buried pipe in the raw water system. Yellow locator ribbon shall be used for the electrical duct bank from riser pole to the transformer. Purple locator ribbon shall be used for the buried leachate transfer lines.

Ribbon shall be tape manufactured by Reef Industries or Allen Markline or equal and shall have metal foil, which is completely encased in plastic and can be easily detected by metal detectors.

The ribbon shall be printed with the manufacturer's standard wording, "CAUTION ELECTRIC LINE BURIED BELOW", for all electrical conduits, phone lines, etc., "CAUTION BURIED PIPELINE BELOW", for all buried pipelines.

TRENCH STABILIZATION MATERIAL:

Granular material from the excavation or stockpile meeting the requirements of structural fill as specified in Section 02315, FILL AND BACKFILL.

PIPE BEDDING:

Pipe bedding material for thermoplastic pipe shall be clean sand/gravel mixture free from organic matter and conforming to the following gradation:

Sieve Size	Percent Passing
3/4″ square	100
3/8″ square	70-100
U.S. No. 4	55-100
U.S. No. 10	35-100
U.S. No. 20	20-80
U.S. No. 40	10-55
U.S. No. 100	0-10
U.S. No. 200	0-5

All percentages are by weight.

PIPE ZONE MATERIAL:

Excavated granular material from required excavations, free from rocks, roots, and organic matter. The maximum particle size shall be 3/4 inch and the percent by weight passing the No. 200 U.S. sieve shall be a maximum 15 percent.

Pipe bedding may be used as substitute for pipe zone material.

EARTH BACKFILL:

Earthfill as specified in Section 02315, FILL AND BACKFILL.

STRUCTURAL FILL:

As specified in Section 02315, FILL AND BACKFILL.

SOURCE QUALITY CONTROL:

As specified in Section 02315, FILL AND BACKFILL.

PART 3 – EXECUTION

TRENCH PREPARATION:

Water Control:

Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.

Remove water in a manner that minimizes soil erosion from trench sides and bottom.

Provide continuous water control until trench backfill is complete.

Remove foreign material and backfill contaminated with foreign material that falls into trench.

TRENCH BOTTOM:

Firm Subgrade: Remove loose and disturbed material and trim off high areas and ridges left by excavating equipment. Tamp to provide a firm and unyielding subgrade. Allow space for bedding material if shown or specified.

Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of over excavation, if any, required.

TRENCH STABILIZATION MATERIAL INSTALLATION:

Rebuild trench bottom with trench stabilization material.

Place material over full width of trench in 8-inch maximum, loose measurement lifts to required grade, providing allowance for bedding thickness.

Compact each lift to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

BEDDING:

Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

Hand grade and compact each lift to provide a firm, unyielding surface.

Minimum Compacted Thickness: As shown on the Drawings. For leachate collection and riser pipes, there shall be no bedding between lining system and pipe.

Direct-Buried Cable: 3 inches.

Duct Banks: 2 inches.

Check grade and correct irregularities in bedding material.

BACKFILL PIPE ZONE:

Upper limit of pipe zone shall not be less than following:

Pipe: 12 inches, unless shown otherwise.
Conduit: 3 inches, unless shown otherwise.
Direct-Buried Cable: 3 inches, unless shown otherwise.
Duct Bank: 3 inches, unless shown otherwise.

Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

Place pipe zone material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

Pipes 10 Inches and Smaller Diameter: First lift less than or equal to 1/2 pipe-diameter.
Pipes Over 10-Inch Diameter: Maximum 8-inch, loose measurement lifts.

Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

Do not use power-driven impact compactors to compact pipe zone material.

LOCATOR RIBBON INSTALLATION:

Continuously install locator ribbon along centerline of all buried piping, at depth of 16 inches below ground surface unless shown otherwise on the Drawings. Coordinate with piping installation drawings.

BACKFILL ABOVE PIPE ZONE:

General:

Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe. Trench backfill using water-settling methods for compaction is not permitted.

Do not use power driven impact type compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Hand-held jump jack type compactors are acceptable for compaction of backfill over top of pipe.

Backfill to grade with proper allowances for topsoil, road gravel subbase, and pavement thicknesses, wherever applicable.

Backfill around structures with same backfill as specified for adjacent trench unless otherwise shown or specified.

Backfill outside the Limits of Roadways, Utilities, and Other Facilities:

Place earthfill in lifts not exceeding 12-inch maximum, loose measurement thickness.

Mechanically compact each lift to a minimum of 90 percent relative compaction prior to placing succeeding lifts.

Backfill Under Facilities, Roadways, and Utilities: Backfill trench above the pipe zone with structural fill in lifts not exceeding 8 inches maximum, loose measurement thickness. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

REPLACEMENT OF TOPSOIL:

Where applicable, replace topsoil in top 6 inches of backfilled trench.
Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

DRAIN GRAVEL BACKFILL FOR LEACHATE COLLECTION (SLOTTED) PIPE, RISER PIPES, AND SUMPS:

Use drain gravel as specified in Section 02315, FILL AND BACKFILL.

Drain gravel shall be placed in sumps by mechanical or hand methods that will not damage pipes or underlying geosynthetics. For areas within 3 feet of leachate collection pipe, riser pipe, and transducer pipe centerline, the Construction General Contractor shall place first lift of drain gravel on both sides of pipe in a 9-inch lift, and succeeding lifts shall be 6 inches maximum. The Construction General Contractor shall thoroughly tamp each lift, including area under haunches with handheld equipment and tools to ensure that voids are completely filled before placing each succeeding lift. After first lift and after the full depth of material has been placed as specified, the Construction General Contractor shall compact the material by a minimum of three passes with a hand-held vibratory plate compactor only over the area within 3 feet of pipe centerline. For LDS Drain Gravel placement within the LDS Sump, outside of 3 feet from the leachate collection pipe centerline, material will be placed in 6-inch maximum lifts and compacted in lifts with a minimum of three passes of the hand-held plate compactor to ensure that firm and unyielding conditions are achieved throughout the entire gravel thickness in the sump. At all other locations, drain gravel shall be track-walked into place with a minimum two passes with a D6M-LGP bulldozer or equal. Equipment limitations and requirements for placing materials over geosynthetics are specified in Section 02315, FILL AND BACKFILL.

BACKFILL FOR GEOSYNTHETIC ANCHOR TRENCHES:

Backfill with material as shown on the Drawings in loose lifts not exceeding 6 inches in thickness and compact using hand-operated equipment or mechanical equipment as approved by the Design Engineer to not less than 90 percent relative compaction.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform in-place density and moisture content tests as specified in Section 02315, FILL AND BACKFILL, to be observed by the Construction Manager, on the following minimum schedule:

Backfill Above Pipe Zone: One per 500 linear feet per lift.

MAINTENANCE OF TRENCH BACKFILL:

After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

SETTLEMENT OF BACKFILL:

Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION 02320

SECTION 02371 – GEOTEXTILES Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D3776	Standard Test Method for Mass per Unit Area (Weight) of Fabric
ASTM D4355	Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Method for Determining Apparent Opening Size
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles

DESCRIPTION:

The Work includes manufacture, fabrication (if needed), supply, and installation of geotextiles associated with the lining of the disposal facility and other applications as shown on the Drawings. This section also applies to geotextiles used in geocomposite drainage layers [see Section 02373, COMPOSITE DRAINAGE NET (GEOCOMPOSITE)].

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Manufacturer's Quality Control (QC) test data for geotextile physical properties, verifying compliance with these Specifications. Data shall include test results, methods, and roll numbers. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan.

Manufacturer's written certification that materials meet the requirements of these Specifications and that geotextile is continuously inspected for presence of needles and found to be needle-free.

CONSTRUCTION QUALITY ASSURANCE (CQA):

Quality assurance procedures for geotextile are presented in the CQA Plan. CQA Plan requirements are discussed in Section 02661, GEOMEMBRANE. The Construction General Contractor shall accommodate all CQA activities described herein and in the CQA Plan for this project.

Prior to placing any materials over the installed geotextile, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA CONFORMANCE TESTING:

Prior to deployment of the rolls of geotextile, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or 50,000 square feet of each material type, whichever results in the greater number of tests. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of certified properties.

As a minimum, the following tests will be performed on geotextiles (each type, except as noted):

Grab Strength: ASTM D4632.

Tear Strength: ASTM D4533.

Puncture Strength: ASTM D4833.

Permittivity: ASTM D4491 (Type 1 only).

The CQA Certifying Engineer shall be allowed to remove samples for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

PART 2 – PRODUCTS

GENERAL:

Types of Geotextiles:

Type 1 (separation) geotextile shall be 6 oz/yd^2 nominal weight and shall be used for separation of soil layers, in the geocomposite drainage layers, and at other locations as shown on the Drawings.

Type 2 (cushion) geotextile shall be 12 oz/yd2 nominal weight and shall be used for cushioning of geomembranes and at other locations as shown on the Drawings.

All geotextiles, regardless of type, shall be nonwoven, needle punched polypropylene.

Manufacturer: The geotextile manufacturer shall be a commercial entity normally engaged in manufacture of geotextiles for landfill applications.

REQUIRED PROPERTIES:

Property Values:

Geotextile properties shall meet or exceed the values specified in Table 1, Required Geotextile Properties, contained in this section of the Specifications (Type 1 and Type 2 geotextiles).

The manufacturer shall provide test results for all properties listed in Table 1 (Type 1 and Type 2 geotextiles).

The manufacturer shall certify that the materials supplied meet the requirements of this Part (Type 1 and Type 2 geotextiles).

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

TRANSPORTATION, HANDLING, AND STORAGE:

Geotextiles shall be supplied in rolls wrapped in covers and marked or tagged with the roll number. Each material roll shall include information to demonstrate material traceability through written documentation from the manufacturer and transport company. At a minimum, this information shall include the Manufacturer's Name, Product Identification, Lot Number, and Roll Dimension (Area and Width).

Transportation of the geotextiles to the site and all handling on site shall be the responsibility of the Construction General Contractor.

During shipment and storage, the geotextile shall be protected from mud, dirt, UV exposure, dust, puncture, cutting, or other damaging or deleterious conditions. Protective wrappings, which are damaged, shall be repaired or replaced, as necessary.

The Construction General Contractor shall be responsible for the storage of the geotextiles on site within the areas shown on the Drawings. The Construction General Contractor shall protect storage area(s) from theft, vandalism, passage of vehicles, etc.

PART 3 – EXECUTION

GENERAL:

Unacceptable Materials and Work: Materials and Work, which fail to meet the requirements of these Specifications, shall be removed and disposed of at the Construction General Contractor's expense. This includes geotextile rolls that are not labeled or where the label has deteriorated to the point of being illegible.

HANDLING AND PLACEMENT:

The Construction General Contractor shall handle all geotextiles in such a manner as to ensure that they are not damaged. Geotextile will be deployed on top of textured HDPE geomembrane in a manner that will not damage the geotextile. If necessary, use a smooth slip-sheet under the geotextile.

Place geotextiles in a manner that prevents folds and wrinkles. Folds or wrinkles shall be pulled smooth prior to seaming.

In the presence of wind, all exposed geotextiles shall be weighted with sandbags or equivalent. Sandbags shall be installed during placement and shall remain until replaced with cover material.

Geotextiles shall be cut using an approved geotextile cutter only. Special care shall be taken to protect underlying geosynthetic materials from damage during cutting.

During geotextile placement, care shall be taken not to entrap stones, excessive dust, or moisture that could damage the geomembrane, clog drains or filters, or hamper subsequent seaming.

Geotextiles shall be placed with the machine direction (long dimension) downslope or normal to the natural slope.

After installation and immediately prior to placing overlying materials, the geotextile shall be examined over its entire surface to ensure that no potentially harmful foreign objects, such as needles, are present. Any foreign objects encountered shall be removed, or the geotextile shall be replaced.

If light colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

After deployment, all geotextile shall be covered to prevent exposure to ultraviolet (UV) radiation (sunlight) within a maximum period of 14 days. If the geotextile is exposed for more than 14 days, a temporary cover may be deployed for the duration of the delay or samples may be submitted to an independent testing laboratory to ensure that detrimental levels of UV degradation have not occurred. Detrimental level of UV degradation is defined as greater than 10 percent loss of required geotextile properties listed in Table 1 for the following:

Grab strength.
Trapezoidal tear strength.
Puncture strength.

JOINTS:

Edge of roll seams are not required to be sewn and shall be overlapped a minimum of 6 inches. End of roll seams are not required to be sewn and shall be overlapped a minimum of 12 inches. No end-of-roll seams shall be allowed on slopes 6H:1V and steeper. Overlaps shall be in the direction of flow with the upstream fabric on top of the downstream fabric.

On the landfill floor, no horizontal seam shall be closer than 3 feet to the toe of the slope or other areas of potential stress concentrations.

Areas to be seamed shall be clean and free of foreign material.

REPAIR:

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

Remove any soil or other material, which may have penetrated the torn geotextile.

Replace torn areas and holes by placing a geotextile patch having dimensions of at least 12 inches greater than the tear or hole. The geotextile patch shall be sewn or heat bonded.

For repairs of the geotextile component of the CDN, a patch shall be heat bonded.

MATERIALS IN CONTACT WITH GEOTEXTILES:

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

No damage to the geotextile.

Minimal slippage of the geotextile on underlying layers.

No excess tensile stresses in the geotextile.

END OF SECTION 02371

Table 1. Required Geotextile Properties

Value[a]

Property	Unit	Type 1	Type 2	Test Method
Mass/Unit Area	oz/yd^2	6.0[b]	12.0[b]	ASTM D5261 or D3776
Apparent Opening Size[b]	U.S. Sieve	70 max opening 100 min opening	—	ASTM D4751
Grab Strength	lb	140	300	ASTM D4632
Trapezoidal Tear Strength ASTM D4533	lb	70		110
Puncture Strength	lb	65	135	ASTM D4833
Permittivity	sec^{-1}	1.2	—	ASTM D4491
UV Resistance % strength	(500 hours)	retained 70	70	ASTM D4355

Notes:

[a]All values are minimum average values, except as noted.[b] Nominal values.

SECTION 02373 – COMPOSITE DRAINAGE NET (CDN) Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D413	Standard Test Method for Rubber Property Adhesion to Flexible Substrate
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D1777	Standard Test Method for Measuring Thickness of Textile Materials
ASTM D4218	Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D5199	Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI-GC7	Determination of Adhesion and Bond Strength of Geocomposites description:

The Work includes manufacture, fabrication (if needed), supply, and installation of geocomposite (hereinafter referred to as composite drainage net (CDN)) drainage layers associated with the lining of waste disposal facility. The CDN shall consist of a layer of geotextile thermally bonded to each side of a geonet. Requirements for geotextiles are contained in Section 02371, GEOTEXTILES, of these Specifications. Requirements for geonets and the finished CDN are contained in this section.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Construction General Contractor shall submit required interface strength data, as specified in PART 2-PRODUCTS, prior to shipment of material to allow Engineer to evaluate if submitted material meets strength requirements for project design criteria. Allow Engineer 20 working days for this evaluation upon receipt of data.

Installation Plan: The Construction General Contractor shall submit a plan describing the proposed methods for CDN deployment, panel layout, seaming, repair, and protection. The plan shall include a quality assurance program for the Construction General Contractor's activities related to CDN installation.

Manufacturer's Quality Control (QC) test data for CDN composition and physical properties, verifying compliance with these Specifications. The data shall include roll numbers, test results, and test methods. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan.

Manufacturer's written certifications that CDN satisfy the requirements of these Specifications.

CONSTRUCTION QUALITY ASSURANCE (CQA):

Quality assurance procedures for CDN installation are presented in the Construction Quality Assurance Plan (CQA Plan). CQA Plan requirements are discussed in Section 02661, GEOMEMBRANE. The Construction General Contractor shall accommodate all quality assurance activities described herein and in the CQA Plan for this project.

Prior to placing any materials over the installed CDN, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA conformance testing:

Upon delivery of the rolls of geonet and CDN, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or one per 50,000 square feet of each material type, whichever results in the greater number of tests; transmissivity shall be as noted below. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of certified properties.

CDN fabricated from non-conforming components shall be rejected at the Construction General Contractor's expense.

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

Polymer specific gravity (ASTM D1505).
Thickness (ASTM D5199).
Nominal transmissivity (ASTM D4716 – one per production lot).

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

Adhesion (GRI-GC7 or ASTM D413).
Transmissivity (ASTM D4716 – one per production lot).

The CQA Certifying Engineer shall be allowed to remove samples of geonet and CDN for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

PART 2 – PRODUCTS

GENERAL:

Composition:

The geonet shall be high-density polyethylene (HDPE), manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

The CDN shall consist of Type 1 geotextile thermally bonded to each side of the HDPE geonet.

Manufacturer: The CDN manufacturer shall have a minimum of 5 years' experience as a commercial manufacturer of CDNs for landfill drainage applications.

REQUIRED PROPERTIES:

Property Values:

Geonet: Geonet properties shall meet or exceed the values specified in the table of required geonet properties contained in this section of the Specifications.

Geotextile: Geotextile properties shall meet or exceed the values specified in Section 02371, GEOTEXTILES, of these Specifications unless otherwise approved by the Engineer.

Finished CDN: CDN properties shall meet or exceed the values specified in the table of required CDN properties contained in this section of the Specifications.

Required Interface Shear Strength Data: Provide data prior to material shipment for the interface friction angle between the CDN and textured geomembrane, and between the CDN and operations layer material, as specified in Article SUBMITTALS. Perform two interface shear strength tests on each interface. Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321) at nominal normal loads of 100, 250, and 500 psf. Report results for both peak and large displacement (minimum 2 inches) strength.

The Engineer will review this data for conformance with project design strength requirements. Construction General Contractor shall not order material for shipment until approved by Engineer. Any product or material changes required as a result of inadequate strength data will be addressed by Change Order provided submitted material meet all other requirements of this section.

Manufacturer's Information: The manufacturer shall provide specification sheets, literature, and test results for all properties listed in these Specifications. The manufacturer shall certify that the materials supplied meet the requirements of this Part.

Integrity: Geonets and CDNs shall retain their structure during handling, placement, and long-term service.

TRANSPORTATION, HANDLING, AND STORAGE:

Geonets and CDNs shall be supplied in rolls wrapped in covers and marked or tagged with the roll number. Each material roll shall include information to demonstrate material traceability through written documentation from the manufacturer and transport company. At a minimum, this information shall include the Manufacturer's Name, Product Identification, Lot Number, and Roll Dimension (Area and Width).

Transportation of the CDN to the site and all handling on site will be the responsibility of the Construction General Contractor.

During shipment and storage, the geonet and CDN shall be protected from mud, dirt, UV exposure, dust, puncture, cutting, or other damaging or deleterious conditions. Protective wrappings, which are damaged, shall be repaired or replaced, as necessary.

The Construction General Contractor shall be responsible for the storage of the CDN on site within the limits of construction. The Construction General Contractor shall protect storage area(s) from theft, vandalism, passage of vehicles, etc.

PART 3 – EXECUTION

GENERAL:

Unacceptable Materials and Work: Materials and Work, which fail to meet the requirements of these Specifications, shall be removed, disposed of, and replaced at the Construction General Contractor's expense.

handling and placement:

The Construction General Contractor shall handle all CDNs in such a manner as to ensure that these materials are not damaged.

Clean geomembrane surface prior to placing CDN.

On slopes, CDN may be deployed over slip-sheets with the roll at the top of the slope. An alternative method is to secure the CDN and then roll it down slope in a manner to continually keep it in tension. If necessary, position the CDN after deployment to minimize wrinkles and remove the slip-sheet, if used.

Do not drag the CDN across textured geomembrane in any way that damages the geotextile component or reduces the friction at the geomembrane/CDN interface.

In the presence of wind, all exposed CDNs shall be weighted with sandbags or equivalent. Sandbags shall be installed during CDN placement and shall remain until replaced with cover material.

Unless otherwise specified, CDNs shall not be welded to geomembranes.

CDNs shall only be cut using approved cutting tools. Protect underlying geosynthetics when cutting.

The Construction General Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the CDN.

During placement of CDNs, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. Dirt or excessive dust entrapped in the CDN shall be cleaned prior to placement of the next material on top of it. Excessive dust is defined as any thickness greater than 20 mils (0.02 inch) within the geonet core of the CDN. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag.

Tools shall not be left in the CDN.

After deployment, all CDN shall be covered within a maximum period of 14 days to prevent exposure of geotextile component to ultraviolet (UV) radiation (sunlight). See Section 02371, GEOTEXTILES, for requirements of geotextile exposed to UV radiation longer than 14 days.

joining:

Adjacent sections of CDN shall be overlapped according to the manufacturer's directions.

Overlaps shall be secured by spot welding or tying. Acceptable tying devices include strings, plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy observation. Metallic devices are not allowed.

Overlaps shall be secured every 5 feet along slopes and on the floor of the landfill. Overlaps shall be secured every 6 inches in anchor trenches. Along end-to-end seams, spot-weld, or tie each row at 6-inch intervals; stagger weld or ties between rows.

In joining CDNs, tearing the geotextile away from the geonet shall only be allowed at panels ends in order to seam same material components together and shall be minimized to the extent necessary to perform the required work.

No horizontal seams shall be allowed on side slopes except at roll ends.

If more than one layer of CDN is installed, joints shall be staggered.

repair:

Remove the damaged area of CDN.

Cut a piece of geonet to fit into the repair area. Geonet shall fit into repair area to form a flush surface with the CDN. Cut geonet so that ribs are in the same orientation as existing CDN.

Remove any dirt or other foreign material, which may have entered the CDN.

Place CDN patch over damaged area. Geonet component of patch shall be tied to in-place geonet component according to manufacturer's recommendations.

Place Type 1 geotextile over the exposed geonet component with an overlap of 4 inches of geotextile. Heat seam repair geotextile to existing geotextile.

MATERIALS IN CONTACT WITH CDNS:

The Construction General Contractor shall place all soil materials located on top of a CDN layer in such a manner as to ensure that the following conditions are satisfied:

No damage to the CDN.
No slippage of the CDN on underlying layers.
No excess tensile stresses in the CDN.

END OF SECTION 02373

Table 1. Required Geonet Properties

Property	Qualifier	Unit	Value	Test
Polymer Composition	Minimum	% polyethylene	95	---
Resin Specific Gravity	Minimum	N/A	0.92	ASTM D1505
Carbon Black Content	Range	%	2 - 3	ASTM D1603 or D4218
Nominal Thickness	MARV	mils	250	ASTM D1777 or D5199
Nominal Transmissivity[(1)]	MARV	m^2/sec	3×10^{-3}	ASTM D4716

Table 2. Required CDN Properties

Property	Qualifier	Unit	Value	Test
Ply Adhesion	ARV	lb/in	1.0	ASTM D413 or GRI-GC7
Transmissivity[(1)]	MARV	m^2/sec	5×10^{-4}	ASTM D4716

Notes:
MARV = Minimum Average Roll Value.
ARV = Average Roll Value.

[(1)]The design transmissivity is the hydraulic transmissivity of the CDN measured using water at 70 degrees F ±3 degrees F with a hydraulic gradient of 0.1, under the compressive stress of 10,000 psf. Transmissivity value shall be measured between two steel plates 15 minutes after application of the confining stress in the machine direction.

SECTION 02500 – RAW WATER CONVEYANCE PIPING - GENERAL Sched. A & B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing raw water piping and associated components.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Standard Specification for Structural Concrete

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm), for Water and Other Liquids
AWWA C115/A21.15	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
AWWA C217	Cold-Applied Petroleum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried Steel Water Pipelines
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C221	Fabricated Steel Mechanical Slip-Type Expansion Joints
AWWA C606	Grooved and Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A497	Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A615/A615M	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement

NSF INTERNATIONAL (NSF)

NSF 61B	Drinking Water System Components - Health Effects

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information.

Documentation for pipe pressure class.

SUBMITTALS–APPROVAL NOT REQUIRED:

INFORMATION/RECORD (IR):

Submit results of pressure leakage testing for raw water conveyance piping.

Submit results for materials and test certificate after completion of the system in accordance with NFPA 24 Chapter 9.

DELIVERY, STORAGE, AND HANDLING:

In accordance with manufacturer's recommendations.

Marking at Plant: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer's identification, specification standard, diameter of pipe, dimension ratio, pipe class, and other information required for type of pipe.

Pipe, specials, and fittings received at Project site in damaged condition will not be accepted.

Gasket Storage: Store rubber gaskets in cool, well-ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

Handling:

Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.

Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.

Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workmen. Slings shall bear uniformly against pipe.

Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 – PRODUCTS

PIPE:

As specified in Section 02502, RAW WATER DUCTILE IRON PIPE AND FITTINGS, Section 02509, RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS, and the Carbon Steel Pipe and Galvanized Steel Pipe Data Sheets attached to this section.

JOINTS:

As specified in Section 02502, RAW WATER DUCTILE IRON PIPE AND FITTINGS, Section 02509, RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS, and the Carbon Steel Pipe and Galvanized Steel Pipe Data Sheets attached to this section.

FLEXIBLE LOCK COUPLINGS:

GENERAL:

Couplings shall be rated for 173 psi.

Buried, bolted, sleeve-type couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

Locking pins shall be integral to coupling, number and diameter of pins per manufacturer's standard.

For Pipe with Plain-Ends: Bolted, sleeve-type coupling, in accordance with AWWA C219.

Manufacturer of couplings shall observe same quality control requirements as specified in AWWA C221 for fabrication of pipe expansion joints.

Manufacturers and Products: Dresser; Style 167.

SERVICE SADDLES:

Double strap type with minimum strap width of 2 inches.

Straps shall be Type 304 stainless steel. Saddles shall be ductile iron, epoxy-coated, 10 mils minimum thickness.

Minimum Pressure Rating: 200 psi.

FLANGES, FLANGE GASKETS, AND BOLTING MATERIALS:

As specified in individual raw water specifications for each piping material.

CONCRETE FOR THRUST BLOCKS:

Thrust Block Concrete: As specified in Section 03301, CONCRETE.

Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

Welded Wire Fabric: ASTM A497.

Formwork: Plywood; earth cuts may be used as approved by Construction Manager.

LOCATOR RIBBON:

As specified in Section 02320, TRENCH BACKFILL.

PIPE BEDDING AND PIPE ZONE MATERIAL:

Granular material as specified in Section 02320, TRENCH BACKFILL.

TRENCH STABILIZATION MATERIAL:

As specified in Section 02320, TRENCH BACKFILL.

PART 3 – EXECUTION

GENERAL:

Installation shall be in accordance with NFPA 24 Standard for the Installation of Private Service Mains and Their Appurtenances.

Notify Construction Manager at least 2 weeks prior to field fabrication of pipe or fittings.

Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.

Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by Construction Manager. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

EXAMINATION:

Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer's instructions.

PREPARATION OF TRENCH:

Prepare trench as specified in Section 02316, EXCAVATION.

Unless otherwise permitted by Construction Manager, maximum length of open trench shall not exceed 500 feet.

INSTALLATION:

GENERAL:

Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

Install individual pipe lengths in according to approved lay diagram. Misplaced pipe shall be removed and replaced.

Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.

Flanged Joints:

Install perpendicular to pipe centerline.

Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on Drawings.

Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.

Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.

Couplings:

Install in accordance with manufacturer's written instructions.

Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.

Remove pipe coating, if necessary, to obtain smooth surface.

Clean gaskets before installation.

If necessary, lubricate with gasket lubricant for installation on pipe ends.

Tighten coupling bolts progressively; drawing up bolts on opposite sides gradually until bolts have uniform tightness.

BURIED PRESSURE PIPE:

Placement:

Keep trench dry until pipe laying and joining is completed.

Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.

Excavate trench bottom and sides of ample dimensions to permit proper joining, visual inspection, and testing of entire joint.

Prevent foreign material from entering pipe during placement.

Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

In general, lay pipe upgrade with bell ends pointing in direction of laying.

Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. Pipe joints shall be pushed together in straight alignment and then deflected. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:

Shorter pipe lengths.
Special mitered joints.

Standard or special fabricated bends.
Check gasket position with feeler gauge to assure proper seating.
After joint has been made, check pipe alignment and grade.
Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
Prevent uplift and floating of pipe prior to backfilling.

Tolerances:

Deflection From Horizontal Line: Maximum 2 inches.

Deflection From Vertical Line: Maximum 1 inch.

Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.

Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.

Cover Over Top of Pipe: Minimum 3.5 feet, unless otherwise shown.

Disposal of Excess Excavated Material: As specified in Section 02316, EXCAVATION.

THRUST RESTRAINT:

Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.

Thrust Blocking:

Quantity of Concrete: Sufficient to cover bearing area of pipe and provide required soil-bearing area as shown on Drawings. For vertical bends, concrete shall be sufficient to provide required volume as shown on Drawings.

Place blocking so pipe and fitting joints are accessible for repairs.

Place concrete in accordance with Section 03301, CONCRETE.

CORROSION PROTECTION:

Buried Pipe: As specified in the individual specifications following this section.

Notify Construction Manager at least 3 days prior to start of surface preparation, coating application, and corrosion protection work.

PLACEMENT OF PIPE LOCATOR RIBBON:

Place pipe locator ribbon in accordance with Section 02320, TRENCH BACKFILL.

PIPE BEDDING AND ZONE MATERIAL:

Place pipe bedding and pipe zone material in accordance with Section 02320, TRENCH BACKFILL.

CONSTRUCTION QUALITY CONTROL:

Pressure Leakage Testing for Raw Water Ductile Iron and PVC: As specified in the individual piping Specification(s) following this section.

Pressure Leakage Testing for Raw Water Carbon Steel Pipe and Fittings and Valves Upstream of 12-Inch Gate Valve:

Shop Test: After fabrication of carbon steel spools (as specified in carbon steel pipe supplement at the end of this section) and prior to lining or coating, blind flanges shall be installed on each flange. One blind flange shall be tapped as necessary for a test port. A hydrostatic leak test shall be performed at 173 psig for 30 minutes; no visible leaks shall be allowed.

Field Test: An in-service leak test shall be performed with excavation open. Retighten bolts on fittings/valves as necessary and within manufacturer's recommendations to stop any visible leaks.

Pressure Leakage Testing for Raw Water Galvanized Steel Pipe and Malleable Iron Fittings: Perform in conjunction with leakage test for raw water ductile iron and PVC.

SUPPLEMENTS:

Supplement 1—Carbon Steel Pipe and Fittings.
Supplement 2—Galvanized Steel Pipe and Malleable Iron Fittings.

END OF SECTION 02500

1 Table 1. Carbon Steel Pipe and Fittings

Item	Size	Description
Pipe	24"	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:
		Schedule 20 (24" OD, 0.375" wall thickness)
		For pressure testing purposes of 24" OD flange x plain end spools, initially construct one flange x flange spool. After completion of pressure testing per Article CONSTRUCTION QUALITY CONTROL of this Specification section, the flange x flange spool shall be cut in half. Each half shall then be coated, lined, and installed per the Drawings. Other flange x flange spools shall be pressure tested prior to coating and lining per Article CONSTRUCTION QUALITY CONTROL.
Joints		Flanged at valves as shown
Flanges		Forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 slip-on or welding neck; weld neck bore to match pipe internal diameter.
		Welding shall conform to AWS D1.1, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict, AWS D1.1 shall govern.
Bolting	All	Carbon steel ASTM A193/A193M, Grade B7 studs and ASTM A194/A194M, Grade 2H hex head nuts.
		When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts and ASTM A563, Grade A heavy hex nuts.
Gaskets	All	General Service and Oil/Gas: 1/16" thick compressed nonasbestos composition flat ring type. Garlock, Style 3000; Manville, Style 978.
Coating		General: Holdback of, and coating shall be as follows: For flex couplings, 8 inches.
		Epoxy Coating:
		Coating system for pipe and flanges (except machined surfaces) shall conform to AWWA C210.
		Paint system for coating shall be Tnemec Series 141 (Color WH03) or approved equal. Completed coating shall have a total dry film thickness of 16 mils minimum.
		Application of epoxy coatings shall be in accordance with federal, state, and local regulations.
		Coatings shall be shop-applied, except for field repairs and holdback areas.
		Materials shall be suitable for temperatures that may be encountered in Project location, and for time of year when materials are being applied and pipeline is being installed.
		Coating shall be tested in accordance with AWWA C210. Defects shall be repaired in accordance with AWWA C210.
		Furnish and apply in field, coat tar epoxy paint, Koppers 300M, or equal, on holdback areas after installation of flex couplings and at damaged coating locations.
Lining		Epoxy Lining: Conform to AWWA C210.
		Lining shall be an epoxy system suitable for potable water service (listed by National Sanitation Foundation Standard 61). Paint system for lining shall be Tnemec Series 141 (Color WH03) or approved equal. Completed lining shall have a total dry film thickness of 10 mils minimum.

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1 Table 2. Galvanized Steel Pipe and Malleable Iron Fittings

Item	Size	Description
Pipe		Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	2" and smaller	Schedule 80.
	2-1/2" through 6"	Schedule 40
Joints	All	Threaded or flanged at valves and equipment.
Fittings		Threaded: 150- or 300-pound galvanized malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded malleable iron, ASTM A197 or A47, 300-pound WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Bolting		Flanges: Carbon steel ASTM A307, Grade A hex head bolts, and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
Thread Lubricant	2" & smaller	Teflon tape or joint compound that is insoluble in water

SECTION 02502 – RAW WATER DUCTILE IRON PIPE AND FITTINGS Sched. A

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing 6-inch ductile iron raw water piping and associated components.

REFERENCES:

The following is a list of standards that may be referenced in this section:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T99	Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5LB) Hammer and a 305mm (12 in.) Drop

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104	Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile Iron Pipe Systems
AWWA C110	Ductile Iron and Grey Iron-Fittings, 3-inch through 48-inch
AWWA C111	Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
AWWA C115	Flanged Ductile Iron Pipe with Ductile Iron and Grey Iron Fittings
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe. Centrifugally Cast, for Water
AWWA C153	Ductile Iron Compact Fittings, 3-inch through 24-inch and 54-inch through 64-inch for Water Service
AWWA C207	Steel Pipe Flanges for Waterworks Service, Sizes 4-inch Through 144-inch (100mm through 3600mm)
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved End, Shouldered Joints

ASTM INTERNATIONAL (ASTM)

ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM B16.21	Standard Specification for Nonmetallic Flat Gaskets for Pipe Flanges
ASTM D882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting
ASTM D1330	Standard Specification for Rubber Sheet Gaskets
ASTM D1922	Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

DUCTILE IRON PIPE RESEARCH INSTITUTE (DIPRA)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Flushing Procedure: The flushing procedure shall outline the method and materials for handling flush water, i.e., pipe, valves, fittings for filling pipeline and similar for discharging flush water, method for restraining aboveground pipe, and preventing erosion damage.

Field Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

Testing dates.
Piping systems and section(s) to be tested.
Method of isolation.
Method of conveying water from source to system being tested.
Calculation of maximum allowable leakage for piping section(s) to be tested.

Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

As-Built Survey Data: Before final acceptance of raw water piping system, provide as-built locations of systems and components, showing pressure pipelines, including grade breaks or alignment, horizontal and vertical locations of all utility crossings, finished grade profile on all alignments, and valve locations. The submitted data shall be certified by a Washington licensed land surveyor.

Shop Drawings: Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating and lining data.

SUBMITTALS–APPROVAL NOT REQUIRED:

INFORMATION/RECORD (IR):

Hydrostatic test documentation form and results.

PART 2 – PRODUCTS

MATERIALS:

Pipe:

General:

Centrifugally cast, grade 60-42-10 iron.
Meet requirements of AWWA C150, C153, and C111.
Lined and coated as specified.

Pipe wall thickness Class 50.

Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 12-inch to 54-inch diameter pipe in accordance with AWWA C115.

Grooved end pipe, for all pipe diameters, shall be minimum Special Class 53.

Pipe shall be new and recently manufactured. Refurbished pipe shall not be provided.

Joints:

Push-On Joint: Rated at minimum working pressure equal to pipe material design.

Restrained Joint:

Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.
Manufacturers and Products:
American Cast Iron Pipe; Flex-Ring and Lok-Ring.
Pacific States Pipe; Thrust-Lock.
U.S. Pipe; TR Flex.

Mechanical Wedge Action Type Joint:

Use only in areas where adjoining to fixed points where laying length is determined in field.
Prior to purchase and installation, type and application of this joint shall be approved by Construction Manager.

Use of setscrews for restraint or field-lock gaskets shall not be allowed.

Flanged Joint: Threaded 250 psi working pressure ductile iron flanges conforming to AWWA C115.

Fittings:

Ductile Iron, Push-On, Flanged, or Restrained Joint: In accordance with AWWA C110, at 250 psi minimum working pressure for 3- to 24-inch fittings and 150-psi minimum working pressure for 30- to 48-inch fittings.

Mechanical Joint Fittings: In accordance with AWWA C111.

Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted.

A. Welded Outlet: Only weld to pipe in manufacturer's shop.

Lining: Pipe and fittings for clean water applications shall be cement lined and asphaltic seal coated in accordance with AWWA C104.

Coating: Asphaltic type, 1 mil thick, in accordance with AWWA C151, C115, C110, and C153.

Bolting: Bolts for flanged connections shall be carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.

Gaskets: Gaskets for flat faced 150 and 250 psi working pressure flanges shall be 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.

PART 3 – EXECUTION

EXAMINATION:

Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

PREPARATION:

Trench Grade:

Grade bottom of trench by hand to specified line and grade, with proper allowance for pipe thickness and pipe base, when specified. Trench bottom shall form a continuous and uniform bearing and support for pipe between bell holes.

Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.

Bell (Joint) Holes: At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides where necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

INSTALLATION:

General:

Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.

Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings, and linings.

Do not drop or dump pipe materials into trench.

Cleaning Pipe and Fittings:

Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.

Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

Laying Pipe:

Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Construction Manager.

Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement.

Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.

When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.

Do not allow foreign material to enter pipe while it is being placed in trench.

Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day's work, or whenever workers are absent from job.

Joining Push-On Joint Pipe and Mechanical Joint Fittings:

Join pipe with push-on joints and mechanical joint fittings in strict accordance with manufacturer's recommendations.

Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.

Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.

Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

Cutting Pipe:

General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and to leave a smooth end, at right angles to axis of pipe.

Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.

Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

Field Welding:

Use of field-welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.

Field installed outlets may be installed with saddle approved by Construction Manager. Opening in pipe shall be machined cut and not with cutting torch.

Field welding of bars for restrained joint systems will not be allowed. All welding shall be performed in pipe manufacturer's shop.

Line and Grade:

Minimum Pipe Cover: 3.5 feet, unless otherwise indicated.

Install pipe to uniform grades and minimize high points.

Maintain pipe grade between invert elevations.

Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Construction Manager.

Pipeline sections that are not installed to elevations shown or installed as approved by Construction Manager shall be reinstalled to proper elevation.

CONSTRUCTION QUALITY CONTROL:

Cleaning:

Following assembly and testing, and prior to final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

If impractical to flush large diameter pipe at 2.5 fps, clean pipe by use of pipe pig as approved by Construction Manager. Multiple passes of pipe pig may be required to adequately clean line.

Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

Pipeline Hydrostatic Test:

General:

Notify Construction Manager in writing 5 days in advance of testing. Construction Manager will coordinate with other parties required to witness testing. Perform testing in presence of Construction Manager.

Test newly installed pipelines. Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.

Furnish testing equipment and perform tests in manner satisfactory to Construction Manager. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.

Isolate new pipelines that are connected to existing pipelines.

Conduct tests on entire pipeline after trench has been backfilled. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

Construction General Contractor may, if field conditions permit and as determined by Construction Manager, partially backfill trench, and leave joints open for inspection and conduct an initial service leak test. Hydrostatic test shall not, however, be conducted until backfilling has been completed.

Procedure:

Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.

Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points.

Test pressure shall be 173 psi as measured at low point of pipeline.

Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.

Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.

Identify method of disposing of water after system testing.

Allowable Leakage: Maximum allowable leakage shall not exceed amount stated in AWWA C600.

END OF SECTION 02502

SECTION 02509–RAW WATER POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

Sched. A & B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing 1-inch and 4-inch Schedule 80 solvent weld, 4-inch and 12-inch bell and spigot, raw water piping and associated components.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 inch Through 48 inch (75 mm Through 1200 mm), for Water and Other Liquids
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch Through 12 inch (100 mm Through 300 mm), for Water Distribution
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inches Through 48 inches (350 mm Through 1,200 mm) for Water Transmission and Distribution
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 inch Through 8 inch (100 mm Through 200 mm)
AWWA Manual M23	PVC Pipe - Design and Installation

ASTM INTERNATIONAL (ASTM)

ASTM D1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2467	Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2672	Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
ASTM D2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

NSF INTERNATIONAL (NSF)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Flushing Procedure: The flushing procedure shall outline the method and materials for handling flush water, i.e., pipe, valves, fittings for filling pipeline and similar for discharging flush water, method for restraining aboveground pipe, and preventing erosion damage.

Qualifications:

Solvent Welders: List of solvent welders and current test records for solvent welder(s) for field solvent welding.

Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

Testing dates.
Piping systems and section(s) to be tested.
Method of isolation.
Method of conveying water from source to system being tested.
Calculation of maximum allowable leakage for piping section(s) to be tested.

Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

As-Built Survey Data: Before final acceptance of raw water piping system, provide as-built locations of systems and components, showing pressure pipelines, including grade breaks or alignment, horizontal and vertical locations of all utility crossings, finished grade profile on all alignments, and valve locations. The submitted data shall be certified by a Washington licensed land surveyor.

Shop Drawings: Drawings showing pipe diameter, pipe class, and fitting details.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Hydrostatic test documentation form and results.

PART 2 – PRODUCTS

MATERIALS:

Bell and Spigot Pipe:

PVC, conforming to requirements of AWWA C900.
DR shall be 14, 200-psi pressure class.

Joints:

Rubber gasketed.
Conform to AWWA C900.

Fittings: Ductile iron, conforming to AWWA C153 or C110.

Solvent Weld PVC Pipe and Fittings: As specified on Piping Data Sheet located at the end of this section as a supplement.

PART 3 – EXECUTION

INSTALLATION OF SCHEDULE 80 SOLVENT WELD PIPE:

In accordance with Section 02500, RAW WATER CONVEYANCE PIPING - GENERAL.

INSTALLATION OF C900 BELL AND SPIGOT PIPE:

In accordance with AWWA C605.

Joints:

Rubber Gasketed: In accordance with manufacturer's written instructions.

Restrained Joint Systems: In accordance with manufacturer's written instructions.

Pipe Bending for Horizontal or Vertical Curves:

Radius of curves shall not exceed 75 percent of manufacturer's recommended values.

Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

Maximum Joint Deflection: 75 percent of manufacturer's recommended values.

CONSTRUCTION QUALITY CONTROL:

CLEANING:

Following assembly and testing, and prior to final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

If impractical to flush large diameter pipe at 2.5 fps, clean pipe by use of pipe pig as approved by Construction Manager. Multiple passes of pipe pig may be required to adequately clean line.

Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

Pipeline Hydrostatic Test:

General:

Notify Construction Manager in writing at least 5 days in advance of testing. Construction Manager will coordinate with other parties required to witness testing. Perform testing in presence of Construction Manager.

Using water as test medium, all newly installed pipelines shall successfully pass hydrostatic leakage test prior to acceptance.

Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Construction Manager, be done prior to placement of asphaltic concrete or roadway structural section.

Construction General Contractor may, if field conditions permit and as approved by Construction Manager, partially backfill trench, and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.

Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.

Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.

Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

Procedure:

Furnish testing equipment, as approved by Construction Manager, which provides observable and accurate measurements of leakage under specified conditions.

Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.

Expel air from piping system during filling.

Test Pressure: 173 psi as measured at low point of pipeline.

Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure.

Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

Identify method of disposing water after system testing.

Maximum Allowable Leakage:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:
L = Allowable leakage, in gallons per hour.
N = Number of joints in tested line.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during leakage test, in pounds per square inch.

SUPPLEMENTS:

Supplement 1—Solvent Weld Polyvinyl Chloride (PVC) Pipe and Fittings.

END OF SECTION 02509

1 Table 1. Solvent Weld Polyvinyl Chloride (PVC) Pipe and Fittings

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
		Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
Bolting	All	ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/ A194M Grade 8M hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber.
		Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Lubricant	All	Teflon tape

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SECTION 02631 – CATCH BASINS Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards that may be referenced in this section:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M105	Standard Specification for Gray Iron Castings
AASHTO M198	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

ASTM INTERNATIONAL (ASTM)

ASTM A536	Standard Specification for Ductile Iron Castings
ASTM C387	Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections

PART 2 – PRODUCTS

PRECAST UNITS:

Precast units shall conform to ASTM C478 except dimensions shall be as shown on the Drawings.

The joints shall be the tongue-and-groove type or the shiplap type, sufficiently deep to prevent lateral displacement. Precast concrete units shall be furnished with knockouts or cutouts.

Rubber gaskets for use in joints of precast catch basin sections shall conform to the applicable requirements of AASHTO M198. Rubber gasket material shall be stored in a clean, cool place, protected from sunlight and contaminants. They shall be protected from direct sunlight at all times except during actual installation.

Concrete risers for extensions shall be a maximum of 6 inches high and of same quality as sections. Risers shall be reviewed by Engineer before installation.

MORTAR:

Standard premixed mortar conforming to ASTM C387, Type S, or proportion 1 part Portland cement to 2 parts clean, well-graded sand which will pass a 1/8-inch screen. Admixtures may be used not exceeding the following percentages of weight of cement: Hydrated lime, 10 percent; diatomaceous earth or other inert materials, 5 percent. Consistency of mortar shall be such that it will readily adhere to concrete.

RINGS AND COVERS:

Castings for catch basin rings shall be gray-iron conforming to the requirements of AASHTO M105, Grade 30B. Covers shall be ductile iron conforming to ASTM A536, Grade 80-55-06.

Catch basin rings and covers shall meet the strength requirements of Federal Specification RR-F-621E. All mating surfaces shall be machine finished to ensure a nonrocking fit.

The horizontal surface and inside vertical recess face of the ring, and the horizontal seating surface and vertical outside edge of the cover, shall be machine finished to the following tolerances:

Ring: +3/32 inch to -3/32 inch.
Cover: +3/32 inch to -3/32 inch.

All catch basin rings and covers shall be identified by the name or symbol of the manufacturer and country of casting origin. This identification shall be in a plainly visible location when the ring and cover are installed. Ductile iron shall be identified by the following, "DUC" or "DI". The manufacturer's identification and material identification shall be adjacent to each other and shall be minimum 1/2-inch to maximum 1-inch high letters, recessed to be flush with the adjacent surfaces.

PART 3 – EXECUTION

EXCAVATION AND BACKFILL:

The excavation for all catch basins shall be sufficient to leave 1 foot in the clear between their outer surfaces and the earth bank. Backfilling of catch basins shall be done in accordance with the provisions of Section 02320 TRENCH BACKFILL. Backfilling around the work will not be allowed until the concrete and mortar have thoroughly set. Any excavation safety systems shall meet the requirements of Section 02316, EXCAVATION.

PLACING PRECAST UNITS:

If material in bottom of trench is unsuitable for supporting unit, excavate and backfill to required grade with 3-inch minus, clean, pit-run material. Set units to grade at locations shown.

Ladder rungs shall be grouted in the precast concrete walls. Rungs shall be uniformly spaced at 12 inches and be vertically aligned.

The ends of all pipes shall be trimmed flush with the inside walls.

Rubber gaskets may be used in tongue-and-groove joints of precast units. All other joints and all openings cut through the walls shall be grouted and watertight.

If gaskets are used, handling of the precast units after the gasket has been affixed shall be done carefully to avoid disturbing or damaging the gasket or contaminating it with foreign material. Care shall be exercised to attain proper alignment before the joints are entirely forced home. During insertion of the tongue or spigot, the units shall be partially supported to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned.

Catch basins shall be watertight.

EXTENSIONS:

Install extensions to height determined by Engineer. Lay risers in mortar with sides plumb and tops to grade. Joints shall be sealed with mortar, with interior and exterior troweled smooth. Prevent mortar from drying out and cure by applying a curing compound. Extensions shall be watertight.

INSTALLATION OF RINGS AND COVERS:

Set rings and covers at elevations indicated or as determined in field and in conformance with Drawings.

Rings may be cast in, or shall be set in mortar.

The cover of a catch basin shall not be grouted to final grade until the final elevation of the adjacent ground surface has been established. Covers shall be seated properly to prevent rocking.

CLEANING:

Upon completion, clean each structure of all silt, debris, and foreign matter.

END OF SECTION 02631

SECTION 02632 – STORMWATER PIPING Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section and any supplemental Data Sheets:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M294	Standard Specifications for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

ASTM INTERNATIONAL (ASTM)

ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Catalog and manufacturer's data sheets for stormwater pipe and fittings.

PART 2 – PRODUCTS

PIPE AND FITTINGS:

Pipe and fittings for culverts and stormwater pipes shall be corrugated polyethylene (CPE) in accordance with the following:

Item	Description
Pipe	AASHTO M294
Pipe Stiffness (Minimum)	In accordance with specified AASHTO Specification
	Profile Type S
Joints	Bell and spigot, gasketed type and water-tight.
	Gaskets ASTM F477
Fittings	Manufacturer's standard; same stiffness as adjacent pipe.
Source Quality Control	In accordance with specified AASHTO Specification.
Factory Testing	Pipe lengths used for deflection testing shall be destroyed after testing.

PART 3 – EXECUTION

INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES:

General:

Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipeline will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

Prevent entry of foreign material into gasketed joints.

Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

Trench excavation and placement of pipe bedding and pipe zone materials shall be in accordance with Section 02320, TRENCH BACKFILL.

Any excavation safety systems shall be in accordance with Section 02316, EXCAVATION.

PIPE CLEANING:

Prior to final acceptance and final inspection of the stormwater pipes by Construction Manager, flush and clean all stormwater pipes and catch basins. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material. If necessary, use mechanical rodding or bucketing equipment.

Upon Construction Manager's final inspection of the stormwater pipes, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

END OF SECTION 02632

SECTION 02661 – GEOMEMBRANES Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D4218	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5397	Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tension Load Test (Appendix A, Single Point)
ASTM D5596	Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI-GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage
GRI-GM13	Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembrane

DESCRIPTION:

The Work includes IDF manufacture, fabrication (if needed), supply, and installation of geomembrane for the lining system, and for other geomembrane applications, as shown on the Drawings. Geomembrane is also referred to as flexible membrane liner (FML).

DEFINITIONS:

CQA Certifying Engineer: Engineer providing independent oversight and responsible for implementing the CQA Plan. Independent is defined as an organization that operates separately from the Construction General Contractor, DOE-ORP, and the Tank Farm Contractor.

Engineer: Design Engineer for the IDF, providing technical design support during construction.

Construction Manager: Construction coordinator overseeing the IDF construction activities in the field and the Tank Farm Contractor's onsite technical representative.

Construction General Contractor: Responsible for overall construction activities and operations, including Construction Subcontractors.

Installer: Construction Subcontractor responsible for installation of geosynthetics (geomembrane, GCL, CDN, and geotextiles).

LCRS: Leachate collection and removal system.

LDS: Leak detection system.

SLDS: Secondary Leak Detection System.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Construction General Contractor shall submit required interface strength data as specified in PART 2-PRODUCTS prior to shipment of material to allow Engineer to evaluate if submitted material meets strength requirements for project design criteria. Allow Engineer 20 working days for this evaluation upon receipt of data.

Installation Plan: The Construction General Contractor shall submit an installation plan describing the proposed methods for geomembrane deployment, panel layout, seaming, repair, and protection. The installation plan shall provide for no field seam locations within the LCRS sump trough under the leachate collection and riser pipes. Construction General Contractor shall orient panel layout such that one full panel width spans the LCRS sump trough. The plan shall also include a quality control program for the Construction General Contractor's activities related to geomembrane installation.

Manufacturer's Quality Control (QC) test data for geomembrane composition and properties as specified in paragraph MANUFACTURING QUALITY CONTROL - POLYETHYLENE GEOMEMBRANES.

Manufacturer's QC certification as specified herein.

The Construction General Contractor shall submit Geomembrane Installer's organizational and seaming personnel qualifications, and other as required to provide the information described in these Specifications.

The Construction General Contractor shall submit Geomembrane Installer's Certificate of Subgrade Acceptability to the CQA Certifying Engineer as specified herein.

Calibration certification for construction quality control test equipment.

SUBMITTALS–APPROVAL NOT REQUIRED:

INFORMATION/RECORD (IR):

Documentation of test results from construction quality control testing.

CONSTRUCTION QUALITY ASSURANCE (CQA):

CQA Plan: A CQA Plan has been prepared as part of the landfill design. The CQA Plan discusses the testing procedures that will be followed by the CQA Certifying Engineer during installation of the geosynthetics (geotextile, CDN, geomembrane, GCL) and the documentation of the process. The CQA Plan is made part of these Specifications by reference. The Construction General Contractor shall conform to the requirements of the CQA Plan for all aspects of the geosynthetics, including submittals, supply, storage, installation, testing, documentation, covering, and protection.

Quality assurance procedures are presented in the CQA Plan. The Construction General Contractor shall accommodate all quality assurance activities described in this section and in the CQA Plan for this project.

Prior to placing any materials over the installed geomembrane, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA CONFORMANCE TESTING:

Upon delivery of the rolls of geomembrane, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or one per 50,000 square feet of geomembrane, whichever results in greater number of tests. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of guaranteed properties.

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

Thickness (ASTM D5994).
Tensile characteristics (yield strength, elongation at yield; ASTM D638).
Asperity (GM-12).
Puncture resistance (ASTM D4833).

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

Sampling Procedures: Samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Certifying Engineer will mark the machine direction on the samples with an arrow.

The CQA Certifying Engineer shall be allowed to remove samples for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

WARRANTY:

The geomembrane manufacturer(s) shall provide warranties on all geomembrane materials installed at the project site. The warranties shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the geomembrane manufacturer. The terms of the warranties shall, at a minimum, include the provisions contained in the most recent version of GRI Test Method GM-13.

PART 2 – PRODUCTS

GENERAL:

Type: High-density polyethylene (HDPE). Unreinforced, 60-mil nominal thickness, textured both sides.

Manufacturer: The HDPE geomembrane manufacturer(s) shall have a minimum of 5 years of experience as a commercial manufacturer of HDPE geomembranes for landfill applications. Examples of potential manufacturers include: GSE Lining Technology, Inc., Houston, TX; and Poly-Flex, Inc., Grand Prairie, TX. Use of these examples is not intended to restrict potential manufacturers.

REQUIRED PROPERTIES - POLYETHYLENE GEOMEMBRANES:

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

Resin Properties: The resin shall meet the following Specifications:

HDPE:

Resin Specific Gravity (ASTM D1505): >0.932.

Melt Index (ASTM D1238 Condition 190/2.16): <1.1 g/10 min.

Finished Sheet Properties: The physical, mechanical, and environmental properties of the finished sheet shall meet or exceed the values specified in Table 1 contained in this part of the Specifications. Where applicable, values in Table 1 are Minimum Average Values.

Required Interface Shear Strength Data: Provide data prior to material shipment for the interface friction angle between the textured geomembrane and other materials (including CDN, GCL, and Admix Liner) directly in contact with the geomembrane as specified in Article SUBMITTALS. Perform two interface shear strength tests on each interface under each set of normal loads.

Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321 or D6243 for GCL interface) at both low normal loads of 100, 250, and 500 pounds per square foot (psf), and high normal loads of 2,000, 8,000, and 15,000 psf. Report results for both peak and large displacement (minimum 2 inches) strength.

The Engineer will review this data for conformance with project strength requirements. Construction General Contractor shall not order material for shipment until approved by Engineer. Any product or material changes required as a result of inadequate strength data will be addressed by Change Order provided submitted material meet all other requirements of this section.

MANUFACTURING QUALITY CONTROL - POLYETHYLENE GEOMEMBRANES:

Quality Control Testing: Quality control testing shall be carried out by the manufacturer to demonstrate that the geomembrane meets the Specifications in this section. Additional testing may be carried out for purposes of determining conformance by the CQA Certifying Engineer. If the results of the manufacturer's and the CQA Certifying Engineer's testing differ significantly, the testing shall be repeated by the CQA Certifying Engineer, and the manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

Required Information: Prior to the delivery of any geomembrane material, the manufacturer shall submit the following information:

The origin (resin supplier's name, resin production plant), identification (brand name, number), and production date of the resin.

A list of quantities and descriptions of materials other than the base polymer, which comprise the geomembrane.

Copies of the quality control certificates issued by the resin supplier.

Reports on the tests conducted by the manufacturer to confirm that the quality of the resin used to manufacture the geomembrane satisfy these Specifications.

A statement that recycled polymer (if any) is clean and does not exceed 2 percent by weight.

A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in these Specifications, or equivalent.

Reports on the tests, including sampling procedures, conducted by the manufacturer to confirm that the geomembrane meets the Specifications.

A certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer.

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

Roll numbers and identification, resin lot, and batch numbers.

Sampling procedures and results of quality control tests. As a minimum, results shall be given for thickness, asperity, tensile strength, and tear resistance in accordance with methods indicated in these Specifications. Tests shall be conducted on each production lot of geomembrane or every 50,000 square feet, whichever results in the greater number of tests.

Manufacturing Plant Visit: The manufacturer shall allow the CQA Certifying Engineer or his designated representative to visit the manufacturing plant, if the CQA Certifying Engineer so chooses. If possible, the visit shall be prior to or during the manufacturing of the geomembrane rolls for the specific project. The CQA Certifying Engineer or his designated representative shall review the manufacturing process, quality control, laboratory facilities, and testing procedures. During the visit, visiting personnel will also:

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

Spot inspect the rolls and confirm that they are free of holes, blisters, or any sign of contamination by foreign matter.

Review packaging and transportation procedures to confirm that these procedures are not damaging the geomembrane.

Confirm that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, and roll number.

If applicable, confirm that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

The geomembrane manufacturer shall accommodate these activities.

EXTRUDATE:

Extrudate for Fusion Welding of HDPE Geomembrane: Formulated from same HDPE resin as geomembrane and shall meet applicable physical property requirements.

FIELD-FABRICATED BOOTS:

Pipes and other structures penetrating the lining system shall be sealed to the geomembrane with fabricated boots made of the same material and workmanship as the lining system geomembrane. The flange portion of each boot shall match the angle of the slope or bottom, be sealed to the geomembrane, and fit smoothly without folds or stretching of the material.

SEALANT CAULKING:

Where shown on the Drawings, the caulking used shall be a one-component sealant formulated of butyl rubber and other selected ingredients, equivalent to Biddle Co., St. Louis, MO, Butylgrip Sealant, or as recommended by the manufacturer of the geomembrane materials.

STAINLESS STEEL CLAMPS:

As indicated on the Drawings, clamps shall be used to secure the HDPE geomembrane to pipes, poles, or risers that are intended to protrude through the cover. One-half-inch wide clamps shall meet or exceed specifications for “Make-a-Clamp” as manufactured by Breeze Clamp Products Division, Federal Laboratory, Inc., Saltsburg, PA.

BUTYL MASTIC TAPE:

Shall be as manufactured by Tremco, Cleveland, OH; or of a type recommended by HDPE geomembrane manufacturer.

NEOPRENE RUBBER PAD:

As indicated on the Drawings, neoprene rubber shall be used as compression strip beneath the stainless steel clamps (ASTM D2240). One-half-inch thick neoprene rubber shall be 35-to 40 durometer hardness, as supplied by Aero Rubber Co., Inc., Bridgeview, IL, or approved equal. Cut to a continuous 2-inch wide piece of neoprene to form the gasket. Neoprene rubber contact cement recommended by the supplier shall be used to bond butt ends of joined strips and to bond neoprene rubber in position on surface. Butt joints in neoprene strips shall be offset from adjacent joints by at least 6 inches.

TENSIOMETER FOR FIELD TESTING:

Motor driven with jaws capable of traveling at measured rate of 2 inches per minute. Equipped with gauge, which measures force in unit pounds exerted between jaws.

PLYWOOD SHEETING:

Use APA rated sheeting EXT for protection of the HDPE geomembrane at termination edges on south side of Phase I.

PART 3 – EXECUTION

GENERAL:

Personnel Qualifications - Polyethylene Geomembranes:

Installer Organization: At a minimum, the Construction General Contractor organization shall have successfully completed at least five projects consisting of installation of at least 5,000,000 square feet (total) of HDPE liner. Projects shall include RCRA landfills.

Seaming Personnel: All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests similar to those described in this section. The superintendent and lead welder foreman shall have experience seaming a minimum of 1,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus proposed for use on this project. These individuals shall provide direct supervision over less experienced seamers. No field seaming shall take place without one of these individuals being present. Key personnel are defined as the superintendent, foreman, and lead welder. Key personnel shall be full time employees of the Geosynthetics Installer.

Applicability: The primary and secondary geomembranes shall be installed at the locations, lines, and grades shown on the Drawings. All geomembranes shall be installed in accordance with these Specifications and the CQA Plan.

Installation Plan: Prior to beginning geomembrane installation, the Construction General Contractor shall submit a plan describing the proposed size, number, position, and sequence of geomembrane panel placement, and location of field seams.

SUBGRADE SURFACE PREPARATION - POLYETHYLENE GEOMEMBRANES:

The Construction General Contractor shall be responsible for preparing the subgrade surface of the soil bentonite liner for the geomembrane. Prepare the underlying soil surface as specified in Section 02319, SUBGRADE PREPARATION, and as approved by the Geomembrane Installer.

The Geomembrane Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the Installer to the Construction General Contractor prior to commencement of geomembrane installation in the area under consideration. The CQA Certifying Engineer shall be given a copy of this certificate by the Construction General Contractor. The form for Geomembrane Installer certification is provided as Supplement to this Specification. Submittal of this form only applies to soil surfaces underlying the geomembrane. In this case Geomembrane Installer Certification of Subsurface Acceptability is only required for the surface on which the secondary and SLDS geomembrane shall be installed.

After the subgrade surface has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the Construction General Contractor any change in the subgrade surface condition that may require repair work.

Special care shall be taken to avoid desiccation cracking or freezing of the admix liner. Specifications for allowable desiccation cracking of soil liner and repair measures are contained in Section 02666, ADMIX

LINER. The surface of the admix liner shall be maintained in the required condition throughout the course of geomembrane installation.

ANCHOR TRENCH EXCAVATION AND BACKFILLING:

The anchor trench shall be excavated to the lines and widths shown on the design Drawings, prior to geomembrane placement. The corners of the trench shall be rounded so as to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. Backfill with material as shown on the Drawings and compact as specified in Section 02320, TRENCH BACKFILL.

GEOMEMBRANE PLACEMENT - POLYETHYLENE GEOMEMBRANES:

Field Panel Identification: A field panel is the unit area of geomembrane, which is to be seamed in the field. Two cases are defined:

If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.

If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It will be the responsibility of the CQA Certifying Engineer to assign each field panel an "identification code" (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Construction Manager, Installer, and CQA Certifying Engineer. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers assigned in the manufacturing plant are usually cumbersome and are not related to location in the field.)

The CQA Certifying Engineer will establish a table or chart showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for all quality assurance records, including Installer's quality control (QC) testing.

Field Panel Placement:

Location: Field panels shall be installed at the locations indicated in the Installer's layout plan, as approved or modified.

Installation Schedule: In general seaming of geomembrane will be performed the same day as deployment. However, at the discretion of Geosynthetic Installer, seaming may be carried over to the following workday.

Placement Conditions: Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface unless installation procedures approved by the CQA Certifying Engineer are in place to address environmental conditions. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. Placement methods shall prevent damage to underlying soil liner or geosynthetic materials.

Factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage shall be considered. Textured-surface sheets shall be aligned in a manner, which maximizes their frictional capabilities along the slope. Maneuver sheets of geomembrane into place in a manner, which prevents wrinkles, folds, or similar distress, which can damage the geomembrane or prevent its satisfactory alignment or seaming. A smooth-surface HDPE geomembrane rub sheet shall be used when

placing textured HDPE geomembrane over underlying GCL. The rub sheet shall be maintained in good condition without tears, rough edges, holes, or scuff marks that can catch, displace, or otherwise disturb the underlying GCL, or the overlying geomembrane.

Damage: Damaged panels or portions of damaged panels, which have been rejected, shall be removed from the work area. Any repairs shall be made according to procedures described in this Part of the Specifications.

Exposed Geomembrane Protection: After panel deployment, all geomembrane, except those shown as permanently exposed on the Drawings, shall be covered to within a maximum period of 20 working days to minimize exposure to temperature cycles that cause expansion/contraction of the geomembrane and desiccation of the underlying admix liner. Exposure in excess of 15 days, Construction General Contractor will peel back leading panel of geomembrane on a routine basis (established by the CQA inspector) for CQA to inspect for desiccation of admix liner. Any observed desiccation observed outside of specification tolerance will be repaired and the geomembrane covered immediately. Additional exposure areas may be required by CQA to verify complete repair areas required. Geomembrane panels shall be covered by other geosynthetic components of the lining system or overlying soil cover materials as shown on the Drawings.

FIELD SEAMING - POLYETHYLENE GEOMEMBRANES:

Seaming Equipment and Products: Approved processes for field seaming are extrusion welding and fusion welding, except that use of extrusion welding shall be limited to areas (such as sumps or repairs) where fusion welding cannot be employed. Proposed alternate processes shall be documented and submitted by the Installer to the Construction Manager and CQA Certifying Engineer for approval. Only equipment, which has been specifically approved by make and model, shall be used.

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

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

The Installer shall comply with the following:

The Installer shall maintain on-site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operation.

The equipment used for seaming shall not be likely to damage the geomembrane.

The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel.

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

Grinding shall be completed no more than 1 hour prior to seaming.

A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

Fusion Process: The fusion-welding machines shall be automated vehicular-mounted devices. The fusion-welding machines shall be equipped with gages giving the pertinent temperatures.

The Installer shall comply with the following:

The Installer shall maintain on site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operations.

The equipment used for seaming shall not be likely to damage the geomembrane.

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

If a build-up of moisture is observed prior to seaming a movable protective layer shall be used directly below each overlap of geomembrane to be seamed to prevent buildup of moisture between the sheets.

Seam Layout:

In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope to the maximum extent practical. In corners and odd-shaped geometric locations, the number of seams shall be minimized. No seams shall be permitted within the LCRS sump trough for leachate collection and riser pipes. One full panel width shall span the LCRS sump trough.

On the landfill floor:

No horizontal seam shall be less than 5 feet from the toe of the slope, or other area of potential stress concentrations.

Over the LCRS, LDS, and SLDS sump areas in each cell, no horizontal seam shall be placed less than 150 feet from the toe of the north slope for a distance of at least 100 feet in each direction from the LCRS and LDS sump centerline.

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

A seam numbering system consistent with the panel numbering system shall be utilized.

Weather Conditions for Seaming: The allowable weather conditions for seaming are as follows:

Unless authorized in writing by the Construction Manager, no seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface.

The geomembrane shall be dry, protected from wind, and free of dust.

If the Installer wishes to use methods, which may allow seaming at ambient temperatures below 32 degrees F, the Installer shall certify in writing that the quality of the seams welded at these temperatures is the same as the quality of seams welded at temperatures above 32 degrees F. In addition, if the Installer wishes to seam at ambient temperatures below 32 degrees F, the following conditions shall be satisfied in addition to the general seaming procedures:

For extrusion welding, preheating shall be performed. Preheating may be waived by the Construction Manager if it is demonstrated to the satisfaction of the CQA Certifying Engineer that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

Sheet grinding, if required, may be performed before preheating.

Observe all areas of the geomembrane that have been preheated to determine that they have not been subjected to excessive melting.

Confirm that geomembrane surface temperatures have not decreased below the minimum specified for welding, due to wind or other adverse conditions. Wind protection for the seam area may be required.

Trial seams, as described in paragraph Trial Seams of this section, shall be made in the immediate area where seaming will occur, under the same ambient temperature and preheating conditions as the actual seams. New trial seams shall be made if the ambient temperature decreases by more than 5 degrees F from the previous trial seam conditions. Such new trial seams shall be conducted as soon as seams in progress during the temperature drop have been completed.

Additional destructive seam tests, as described in paragraph Destructive Seam Strength Testing of this section, shall be performed at intervals of 250 to 500 feet of seam length at the CQA Certifying Engineer's discretion.

The Installer shall provide sample coupons cut from each end of the seam.

Seam Preparation:

Cleaning: Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. Special attention shall be paid to cleaning the existing geomembrane at tie-in locations.

Overlap: Cross slope, seams on both the trench floor and sideslopes shall be overlapped so that liquids are not trapped, i.e., seams shall be shingled downslope. If seam overlap grinding is required, the process shall be completed according to the geomembrane manufacturer's instructions within 1 hour of the seaming operation, and in a way, that does not damage the geomembrane. Panels of geomembrane shall have a finished overlap of a minimum of 3 inches for extrusion welding and 5 inches for fusion welding.

Use of Solvents: No solvent or adhesive shall be used.

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

General Seaming Procedure: The general seaming procedure used by the Installer shall be as follows:

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

If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

If seaming operations are carried out at night, adequate illumination shall be provided.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed, and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

CONSTRUCTION QUALITY CONTROL TESTING - POLYETHYLENE GEOMEMBRANES:

General: Testing requirements specified herein are intended for the Construction General Contractor (and Geomembrane Installer) during geomembrane installation. Testing requirements for the CQA Certifying Engineer are provided in the CQA Plan.

Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. A trial seam shall be made prior to each seaming period (maximum of 6 hours) for each seaming machine used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 2 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in this Part.

Test three specimens for peel and two specimens for shear. Each specimen shall be at least 1 inch wide and shall be cut from the trial seam sample by the Installer. The specimens shall be tested respectively in shear and peel using a field tensiometer, and they shall not fail in the seam. All trial seam specimens must meet the minimum requirements of Table 2, Required Seam Properties, for trial seam acceptance. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall provide the Construction Manager and CQA Certifying Engineer with current calibration certificates.

Nondestructive Seam Continuity Testing:

General: The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method (i.e., spark test). Vacuum testing and air pressure testing are described below. The purpose of the nondestructive test is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be done as the seaming work progresses. Nondestructive testing will not be permitted before sunrise or after sunset unless the Construction General Contractor demonstrates to the CQA Certifying Engineer their capability to perform testing under reduced light conditions. Any seams, which fail nondestructive testing, shall be repaired in accordance with these Specifications. Seams, which cannot be nondestructively tested because of seam geometry, shall be double welded or capped.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

Vacuum Testing: The equipment shall be comprised of the following:

A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gage.

A steel vacuum tank and pump assembly equipped with a pressure controller and connections.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and wide paint brush.

A soapy solution.

The following procedures shall be used:

Energize the vacuum pump and reduce the tank pressure to a minimum of 5 inches of mercury.

Wet a strip of geomembrane approximately 12 inches wide by 48 inches long with the soapy solution.

Place the vacuum box over the test area.

Close the bleed valve and open the vacuum valve.

Ensure that a leak tight seal is created.

For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear coming from the seam after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.

All areas where soap bubbles appear shall be marked and repaired in accordance with this Part.

Air Pressure Testing: The following procedures are applicable only to those processes, which produce a double seam with an enclosed air channel. All double seams with an enclosed air channel shall be air pressure tested. The equipment shall be comprised of the following:

An air pump (manual or motor driven) capable of generating and sustaining a pressure of 60 to 65 psi.
A rubber hose with fittings and connections.
A sharp hollow needle, or other approved pressure feed device.
A calibrated pressure gage capable of reading pressures up to 65 psi.

The following procedures shall be used:

Seal both ends of the seam to be tested.

Insert needle with pressure gage, or other approved pressure feed device, into the air channel created by the fusion weld.

Energize the air pump and pressurize the channel to a minimum 25 psi for a 1/2-inch wide channel, or 55 psi for a 1-inch wide channel. Close the valve and sustain the pressure for a minimum of 5 minutes.

If loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with this section. If significant changes in geomembrane temperature occur during the test (e.g., due to cloud cover), the test shall be repeated after the geomembrane temperature has stabilized.

Cut end of seam opposite to the pressure gage and observe that the pressure drops. If the pressure does not drop, locate the obstruction(s) in the seam, repair, and retest seam.

Remove needle or other approved pressure feed device and repair seam.

Destructive Seam Strength Testing:

General: Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses. The samples shall meet the requirements of Table 2, Required Seam Properties.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

Each sample shall be tested for bonded seam shear and peel strength by an independent testing laboratory.

Test at least five specimens for each seam test method (shear and peel). Four out of five specimens must meet the minimum requirements of Table 2, Required Seam Properties, for field seam acceptance.

Location and Frequency: Destructive seam samples shall be obtained from actual fabricated field seams as work progresses, not at the completion of field seaming. The CQA Certifying Engineer will select locations where seam samples will be removed.

Sampling frequency shall be a minimum of one sample per 500 feet of seam length per welding machine (this minimum frequency shall be determined as an average taken from all the panels, including welds for

caps), or a minimum of two samples per factory panel, whichever gives the largest number of samples. If agreed by all parties (Construction General Contractor, Construction Manager, and the CQA Certifying Engineer) the frequency of destructive seam testing may be reduced to one sample per 1,000 feet of seam if test results and other nondestructive seam tests appear adequate for assuring seam quality. If, based on the specified test frequency, a destructive test location should fall within the LCRS or LDS sump area (as shown on the Drawings); the distance between destructive tests shall be reduced to relocate the destructive test location outside the sump area.

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

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

Sample Size: The samples shall be minimum 12 inches wide by minimum 42 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the samples, and these shall be tested in the field as described below. The remaining sample shall be distributed as follows:

One portion (minimum 12 inches by 12 inches) to the Installer for laboratory testing at his discretion.

One portion (minimum 12 inches by 12 inches) to the Construction Manager for archive storage.

One portion (minimum 12 inches by 18 inches) to the CQA Certifying Engineer for laboratory testing.

Field Testing: The two 1-inch wide strips described above shall be tested in the field by tensiometer for peel and shear and shall not fail in the seam. If any test sample fails to pass, then the procedures outlined below (Procedures for Areas Failing Destructive Tests) shall be followed.

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

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

The Installer shall cap the seam between any two passing test locations, or

The Installer shall trace the seam to two intermediate locations 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full samples shall be taken for laboratory testing. If these laboratory samples pass the tests, then the seam shall be capped between these locations. If either sample fails, then the sampling and testing process shall be repeated to establish the zone over which the seam shall be capped.

All acceptable capped seams shall be bounded by two locations from which samples passing CQA laboratory destructive tests have been taken. In cases where the length of the capped seam exceeds 150 feet, a sample of the capping seam shall be taken and shall pass destructive testing as described in this Part.

REPAIRS - POLYETHYLENE GEOMEMBRANES:

General: Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. All repairs shall be conducted in accordance with this Part. All repairs shall be subjected to the nondestructive seam testing procedures described in this Part.

Each patch or other type of repair will be numbered and recorded.

Repair Procedures:

Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

Grinding and rewelding, used to repair small sections (typically with a maximum length of no more than several inches) of extruded seams.

Spot welding or seaming used to repair pinholes.

Capping, used to repair large lengths of failed seams or areas where large wrinkles or fish mouths have been cut to flatten the geomembrane sheet.

Topping, used to repair areas of inadequate seams, which have an exposed edge. Topping shall be limited to an aggregate length of no more than 3 m (10 feet) on any given seam.

Removing bad seam and replacing with a strip of new material welded into place, used with large lengths of fusion seams.

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

Surfaces of the geomembrane, which are to be repaired, shall be abraded no more than one hour prior to the repair.

All surfaces shall be clean and dry at the time of the repair.

Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

Verification of Repairs: Each repair shall be numbered and recorded. Each repair shall be nondestructively tested using the methods described in this Part. Large caps may be of sufficient extent to require destructive test sampling. Repairs that fail nondestructive or destructive tests shall be redone and retested until a passing test is obtained.

PROTECTION OF TERMINATION EDGES:

Along the south termination of the geomembrane, and along any termination edges of the membrane that may be exposed or buried for extended periods of time prior to their joining to adjacent subsequent sections, the Construction General Contractor shall protect leading edges with protective (sacrificial) layers of cushion geotextile and plywood sheet as shown on the Drawings.

MATERIALS IN CONTACT WITH GEOMEMBRANE:

The requirements of this Part are intended only to assure that the installation of other materials does not damage the geomembrane. Additional requirements as established in other sections of these Specifications are necessary to assure that systems built with these other materials are constructed in such a way as to provide proper performance. Material requirements for operations layer and drain gravel are specified in Section 02315, FILL AND BACKFILL.

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

Do not place granular materials in manner that will cause wrinkles to fold over or become confined to form a vertical ridge. Maximum wrinkle height shall be 4 inches and spacing between wrinkles shall be greater than 10 feet prior to placement of granular materials over the geomembrane.

Minimum Thickness: Equipment used for spreading granular material shall not be driven directly on the geomembrane. A minimum thickness of 1 foot of granular material shall be maintained between spreading equipment and the geomembrane. A minimum thickness of 3 feet of granular material shall be maintained between rubber-tired hauling vehicles and the geomembrane. Construction haul vehicles shall have a maximum ground contact pressure of 25 psi.

Spreading Equipment: Equipment used for spreading granular material shall be a light low ground pressure dozer (such as a wide-pad Caterpillar D6M LGP or lighter), low ground pressure excavator (Bucyrus-Erie 325H with 0.91-m [36-in] wide treads or lighter), or approved equal, with a maximum ground contact pressure of 5 psi.

Spreading Operations: Spreading equipment operating on soil materials shall not spin their tracks, make sharp turns, or make sharp, rapid starts or stops. Soil materials shall be pushed carefully from previously placed material and not dumped directly onto geosynthetics except for the drain gravel in the LDS sump and operations layer material in SLDS sump. This material shall be carefully dumped onto the cushion geotextile or SLDS CDN from a maximum height of 24 inches.

The spreading operation on the sideslope (3H:1V) shall begin at the lower elevations and shall proceed either upslope or laterally at about the same elevation such that a full layer of granular material is always covering the geomembrane downslope from the area being covered. In no case shall the lift thickness be less than the stated minimum. Material shall be placed in such a manner that no air is trapped underneath the geomembrane. Provide and maintain a means of continuously observing the depth of granular materials such as by freestanding markers until placement is complete, at intervals of 50 feet maximum each way. Sharpened stakes or methods that could damage the geomembrane will not be allowed.

LINING SYSTEM ACCEPTANCE - POLYETHYLENE GEOMEMBRANES

The Installer shall retain all ownership of and responsibility for the geosynthetics in the lining system until acceptance by the Construction Manager.

The geosynthetic lining system will be accepted by the Construction Manager when all of the following requirements have been satisfied:

The installation is finished.

Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

A written construction report, including “as built” drawings and all other installation documents, has been prepared by the CQA Certifying Engineer, sealed by a registered professional engineer, and received by the Construction Manager.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION”, are a part of this Specification.

Table 1. Required Geomembrane Properties, 60-mil Textured HDPE.
Table 2. Required Seam Properties.
Geomembrane Installer's Certification of Subsurface Acceptability.

END OF SECTION 02661

Table 1. Required Geomembrane Properties 60-Mil Textured Hdpe

Specified Property	Qualifier	Unit	Value	Test Method
Physical Properties				
Thickness	min. avg. value	mils	60	ASTM D5994
	minimum		54	ASTM D5994
Specific Gravity	minimum	`N/A	0.932	ASTM D1505
Melt Index	range	g/10 min	<1.1	ASTM D1238 condition 190/2.16
Asperity	min avg. value[1]	mils	10	GRI-GM12
Mechanical Properties				
Tensile Properties	(each direction)		(Type IV)	ASTM D638
Strength at yield	min. avg. value	lb/in	120	
Elongation at yield[2]	min. avg. value	%		12
Tear Resistance	min. avg. value	lb	42	ASTM D1004
Puncture Resistance	min. avg. value	lb	80	ASTM D4833
Carbon Black Content	Range	%	2-3	ASTM D1603 or D4218
Carbon Black Dispersion	Minimum[i] 8 of 10	category	1 or 2	ASTM D5596
Environmental Stress				
Crack	minimum[3]	hrs	200	ASTM D5397

[1] Of 10 readings, 8 out of 10 must be greater or equal to 7 mils, and lowest individual reading must be greater or equal to 5 mils. Provide data for both sides of textured geomembrane.
[2] Yield elongation is calculated using a gauge length of 1.3 inches.
[3] Minimum = mean minus 3 standard deviations from documented manufacturer's quality control (MQC) testing.

Table 2. Required Seam Properties Hdpe Geomembranes

Property	Qualifier	Unit	Specified Value	Test Method
Shear Strength[1]	minimum	lb/in width	90% of tensile strength at yield as listed in tables in this section	ASTM D6392
Peel Adhesion	minimum	lb/in width	60% of tensile strength at yield as listed in tables in this section and FTB[2]	ASTM D6392

[1]Also called "Bonded Seam Strength".

[2]FTB = Film Tear Bond (failure occurs through intact geomembrane, not through seam).

Geomembrane Installer's Certification of Subsurface Acceptability

The geomembrane installer, _____
for the Integrated Disposal Facility (IDF), hereby certifies that the supporting prepared subgrade surfaces are acceptable for installation of the HDPE geomembrane lining system, the undersigned having personally inspected the condition of the constructed surfaces. This certification is for the areas shown on Attachment or defined as follows:

_____

_____

_____

_____

The condition of the supporting surfaces in the defined area meets or exceeds the minimum requirements for installation of the geomembrane.

Signed:_____	Signed:_
Geomembrane Installer	Construction General Contractor
_____	_____
Date Signed	Date Signed

SECTION 02666-ADMIX LINER Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft^3) (600 Kn-m/m^3)
ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D2216	Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D6391	Standard Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

DESCRIPTION:

This section describes the low permeability admix that will be used in the liner of the disposal facility. In addition requirements for base soil in the lining system are specified.

The admix liner is an admixture that consists of natural base soil which is mixed with bentonite and moisture conditioned.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

The Construction General Contractor shall submit a detailed plan for preparation of the admix material, including a description of the equipment and procedures to be used, personnel qualifications, and methods for monitoring bentonite additions and moisture conditioning. This plan shall be approved by the Engineer prior to the start of admix production.

The Construction General Contractor shall submit an admix liner placement plan to specify lift thickness control and to allow for required testing, specified herein and described in the CQA Plan, on the soil liner during placement operations. This plan shall be approved by the Engineer prior to the start of admix placement.

Supplier's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the bentonite proposed for use in the admix complies with the requirements of these Specifications. The manufacturer shall certify that the bentonite furnished complies with these Specifications. A certificate shall be submitted to the CQA Certifying Engineer for each railcar or every three truckloads of bentonite delivered.

Certificates for equipment calibration.

CONSTRUCTION QUALITY ASSURANCE:

Construction Quality Assurance testing will be provided by the CQA Certifying Engineer and shall be performed in accordance with the CQA Plan. The Construction General Contractor shall make allowances for sampling and testing by the CQA Certifying Engineer in both his production operations and schedule.

Prior to placing any materials over the completed admix liner, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan. The Construction General Contractor shall accommodate all CQA testing and sampling activities, as specified in the CQA Plan (i.e., in addition to the QC testing), and shall repair sample locations as specified herein.

DEFINITIONS:

Grain Size: Determined by ASTM D422.

Imported Material: Meets requirements of this Specification and is obtained offsite and transported to site.

Natural Moisture Content: Determined by ASTM D2216.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Admix: Natural material (base soil), as specified in this section, that when mixed with bentonite.

Admix Liner: Compacted liner component consisting of admix materials, designed, formulated, and constructed to provide low-permeability barrier against infiltration of liquids or contaminants.

TOLERANCES:

Thickness of the admix liner shall be a minimum of 3 feet and tolerances for the top of admix grade shown on Phase I Primary Liner Plan shall be minus 0.1 foot to plus 0.3 foot. The top surface of the admix liner along the north-south centerline of each cell shall be graded to provide a minimum slope of 1.0% for the LCRS collection pipe installation. The minimum required thickness of the soil liner layer shall be maintained. The as-built elevations of the underlying prepared subgrade shall be used as the basis for determining the final elevation of the soil liner layer.

PART 2 – PRODUCTS

BENTONITE:

The bentonite shall be Bara-Kade 90, manufactured by Bentonite Performance Materials, Inc.; or approved equal. Do not provide calcium bentonites or chemically treated sodium bentonites.

The bentonite to be used in the admix shall consist of a commercially prepared material and shall have the following index properties:

High Swelling: Ability of 2 grams of base bentonite, when mechanically reduced to minus 100 mesh, to swell in water to an apparent volume of 20 cubic centimeters or more when added gradually to 100 cubic centimeters of distilled water contained in graduated cylinder.

Dry Fineness: 65 percent minimum passing No. 200 U.S. Sieve.

The Construction General Contractor shall provide suitable containers on site to store bentonite in a dry condition prior to use.

BASE SOIL:

The base soil for the admix liner shall consist of natural soil derived from the admix base soil borrow area shown on the Drawings, as specified in Section 02317, BORROW AREA EXCAVATION, or from site excavations. Base soil from either source shall not be excavated below a depth of 5 feet below ground surface (after stripping) without evaluation of the material suitability and approval from the Engineer. This material may be temporarily stockpiled at the stockpile area as shown on the Drawings, or within processing area within Phase I as approved by the Construction Manager.

Base soil excavated from dune sand borrows area or site excavation shall meet the following requirements: The base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious material. Rocks greater than 1 inch in dimension shall not comprise more than 2 percent by weight of the base soil. Base soil shall have 20 percent minimum passing No. 200 U.S. Sieve. Base soil shall be screened or otherwise processed if necessary to meet this requirement.

For evaluating compliance with these requirements, test results shall be considered acceptable when the average value of the data satisfies the associated criterion. Testing and sampling frequency for base soil compliance is provided in the CQA Plan.

ADMIX LINER MATERIAL (ADMIX):

Composition: The admix shall consist of the base soil mixed with a nominal bentonite content of 12 percent by dry weight of base soil by dry weight. The acceptable range for bentonite content shall be a minimum of 11 percent and maximum of 14 percent of base soil by dry weight. The bentonite percentage and moisture content range may change as a result of preconstruction testing performed on the test pad as described in the CQA Plan, and may be modified by the Construction General Contractor with the approval of the Construction Manager, Engineer, and the CQA Certifying Engineer at any time during the admix processing to reflect changes in the base soil or other components. The moisture content and bentonite dispersion in the admix shall be uniform and homogenous. The finished admix shall be a uniform homogenous material.

CQA Testing: The admix shall be prepared by the Construction General Contractor and tested by the CQA Certifying Engineer in accordance with the CQA Plan. The Construction General Contractor shall make the admix stockpiles available to the CQA Certifying Engineer at all times for sampling, testing, or visual observation.

Raw Water Supply: See Section 02200, SITE PREPARATION, and the Drawings for information on raw water supply availability and requirements for admix processing and admix liner placement and compaction.

PART 3 – EXECUTION

ADMIX PROCESSING:

Bentonite Use Monitoring: Record weight of bentonite used and volume of admix produced each day.

Processing Using Pugmill:

The Construction General Contractor shall process and condition admix material using a central type pugmill plant prior to compaction. The pugmill shall have automated controls to continuously control the

established proportions of bentonite and water as ratios of the base soil. It shall have provisions to easily change the proportions. It shall be capable of maintaining a constant time of mixing and varying the rate of discharge so that the degree of mixing can be controlled if necessary to achieve complete mixing.

The Construction General Contractor shall provide all necessary equipment and labor to operate the pugmill, load material into pugmill, offload admix, and stockpile admix.

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

Continuous mixing pugmill. Blades shall be adjustable for angular position on shafts and shall be reversible to retard flow of mix.

Belt scales on base soil, bentonite, and finished product belts.

Feed rate meters and totalizers for bentonite, base soil, and water.

Production rate meters and totalizers for finished product.

Variable speed hydraulic supply water pumps capable of producing 500 tons per hour of admixture.

Calibration:

After setting up the pugmill, it shall be calibrated to determine the accuracy of the feed rate for each material being mixed. When the feed controls are set at any desired rate, the measured accuracy shall be within 1 percent by weight of the indicated feed rate for the item being mixed. The accuracy will be determined by operating each feed control separately and collecting and weighing the material over a given period of time as determined by the CQA Certifying Engineer. The material shall be collected in a dump truck (or appropriate container) supplied by the Construction General Contractor, and the truck will be weighed by the Construction General Contractor and verified by the CQA Certifying Engineer before and after loading. During admix production; the CQA Certifying Engineer may request a recalibration of the feed rate for each material as described above.

All measuring equipment shall be calibrated and calibration certificates provided to the CQA Certifying Engineer prior to starting admix production.

Preparation Requirements:

The base soil shall be processed through a pugmill to add bentonite at the specified rate, to add additional water if required, and to provide mechanical mixing action required to homogeneously blend the bentonite and water into the mix. Additional mixing by rotovator or other approved means shall be performed at the Construction General Contractor's sole expense as required to further break down the soil clumps or if additional mixing is needed to achieve a homogenous blend of soil, water, and bentonite. The admix shall be broken down in size sufficiently to result in at least 80 percent of the soil clumps broken down to 1/2 inch in maximum size. Clods are defined as dry hard particles in the admix that cannot be remolded by hand pressure.

If mixing is found to be insufficient to produce a thoroughly blended, uniform mixture of base soil and bentonite, or the base soil and bentonite are not being mixed in the specified proportions, the Construction General Contractor shall stop production of admix material. The Construction General Contractor shall not restart production and installation of admix liner until procedures and equipment have been modified so that the specified material is produced. Admix liner that is installed without complete mixing or the correct percentage of bentonite shall be removed and modified by the Construction General Contractor to meet the Specifications. After being modified to meet the Specifications, the material may be reinstalled in the lining. Additional work and delays caused by inadequate or incorrect mixing shall be performed at

the Construction General Contractor's sole expense. The Construction General Contractor shall not change the bentonite application rate unless directed to do so by the Engineer in writing.

Admix shall be processed and allowed to cure at least 12 hours prior to placement. The Construction General Contractor shall be responsible for maintaining the moisture content of the admix within the specified limits. Admix that does not meet Specifications shall not be reused as feed stock unless approved by the Engineer and CQA Certifying Engineer.

TEST PAD(S):

Test pads for the admix liner shall be constructed as specified in Article ADMIX LINER PLACEMENT AND COMPACTION, by the Construction General Contractor to determine acceptable placement and compaction methods to produce a low-permeability admix liner that satisfies the requirements of this section. Both a horizontal and sideslope test pad shall be constructed. The location of the test pads will be designated by the Construction Manager and the CQA Certifying Engineer.

Test Pad Material: The Construction General Contractor will prepare a sufficient quantity of soil for the test pad in accordance with the requirements of Article ADMIX LINER MATERIAL. All specified procedures for mixing, conditioning, and stockpiling of the soil material will be followed.

Horizontal Test Pad Construction:

The test pad will be constructed on a horizontal surface within the limits of the IDF in an area representative of conditions beneath the waste disposal cells. The pad will be located in a well-drained area to prevent surface water intrusion or saturation of the test pad soils. The test pad location will be cleared and grubbed, and the subgrade will be compacted in the same manner anticipated for construction beneath the waste disposal cells. Prior to placement of the test pad materials, the Contractor's Site Superintendent and the CQA Certifying Engineer will evaluate the condition of the subgrade; areas containing potentially unsuitable materials will be replaced, or another location will be selected for the test pad.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the construction compactor drum width to be used for the full-scale facility and allow for installation of field permeability testing per method ASTM D6391 or 50 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into "lanes" to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the construction compactor drum equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article ADMIX PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

The test pad constructed will include the removal and replacement of a portion of the soil to evaluate the method proposed for repairing defective portions of the full-scale liner as specified in Article REPAIR OF ADMIX LINER.

Sideslope Test Pad Construction:

The sideslope test pad will be constructed on a 3H:1V sideslope (within the lined area of Phase I) to evaluate compaction methods and performance on the sideslope. Field permeability testing is not required for sideslope test pad. Sideslope test pad will be used to demonstrate that compaction and placement methods to achieve acceptable moisture and density requirements can be achieved.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the widest piece of construction equipment to be used for the full-scale facility or 40 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into "lanes" to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the widest piece of construction equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article SOIL BENTONITE PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

Demonstrate the Following During Test Pad(s) Construction:

Base soil/bentonite mixing process prior to compaction.
Compaction equipment type, configuration, and weight.
The method used to break down clods before compaction and maximum resulting clod size.
The speed of compaction equipment traveling over the test pad.
Moisture content of soil bentonite at time of compaction.

Lift thicknesses (compacted), compaction procedures, and number of passes for proposed compaction equipment.

Dry unit weight achieved and measured by field density testing.

Hydraulic conductivity of compacted test fill on undisturbed samples (Shelby Tubes) as described in the Construction Quality Assurance (CQA) Plan.

Field permeability of compacted test fill using ASTM D6391 (horizontal test pad only) as described in the CQA Plan.

Excavate at least four holes, each 3 feet square, through each completed pad for observation, sampling, and testing of compacted material. These holes shall be used for the purpose of demonstrating repair methods as specified herein.

No admix liner shall be placed until the associated test pad has been constructed and the results from all test methods indicate that the admix liner will satisfy the permeability requirements specified in this section. Testing for each test pad shall be as described in the CQA Plan. At the completion of the test pad(s), the CQA Certifying Engineer, as described in the CQA Plan, will prepare an interim report with recommendations for compaction and placement methods to be applied to the full-scale admix liner construction.

After all testing has been completed and approved, the material in the test pad can be used by the Construction General Contractor for liner construction provided that the material satisfies the requirements of these Specifications.

SUBGRADE PREPARATION:

As specified in Section 02319, SUBGRADE PREPARATION, Article PREPARED SUBGRADE FOR ADMIX LINER.

ADMIX LINER PLACEMENT AND COMPACTION:

Lift Thickness: Admix liner material, as specified in Article ADMIX LINER MATERIAL, shall be placed in loose lifts, and compacted such that the compacted lift thickness is 6 inches or less (within a tolerance of 0.1 foot). However, the first lift of admix liner placed over subgrade soils may be placed and compacted to a maximum thickness of 8 inches (within a tolerance of 0.1 foot).

Placement methods shall prevent excessive mixing of admix liner with subgrade soil.

Compaction: The intent of this Specification is that admix liner shall be produced to meet an in-place performance specification of less than $1x10^{-7}$ cm/sec hydraulic conductivity within the limits of edge of liner shown on the Drawings. See paragraph Outside Edge of Liner in this Article for compaction and hydraulic conductivity requirements beyond edge of liner. The Construction General Contractor is responsible to develop and use compaction methods that produce the required relative compaction.

The moisture-density ranges of the compacted admix shall lie within a trapezoidal-shaped field with the following corners:

Moisture Content (%)	Dry Density (pcf)
8	126
12	110
14	126
19	110

Hydraulic Conductivity: The in-place compacted admix liner shall achieve a saturated hydraulic conductivity as listed below:

All field (in-situ) test results shall be 1×10^{-7} cm/sec or less. Field (in-situ) hydraulic conductivity tests will be performed only on admix liner of the horizontal test pad.

All hydraulic conductivity during admix production placement will be verified on undisturbed Shelby tube samples (see ASTM D1587) obtained from in-place admix liner per the CQA plan and then tested in laboratory using methods as described in ASTM D5084.

Hydraulic conductivity will be verified on undisturbed samples from completed areas of the liner as described in the CQA Plan. The arithmetic average of laboratory test results on undisturbed Shelby tube samples shall be less than or equal to 5×10^{-8} cm/sec, with no individual test result exceeding 1×10^{-7}cm/sec. The acceptable values for laboratory test results will be verified or adjusted prior to admix liner production placement based on the correlation of field and laboratory hydraulic conductivity test results from the horizontal test pad. The final laboratory hydraulic conductivity requirement will be approved by the CQA Certifying Engineer and documented in the horizontal test pad report.

Outside Edge of Liner: Compact admix liner as specified herein. Performance specification for admix hydraulic conductivity do not apply to admix placed beyond edge of liner.

Uniformity: The compacted soil distribution and gradation throughout the liner shall be free from lenses, pockets, streaks, layers, or material differing substantially in texture, moisture content, dry density, or gradation from surrounding material. The admix liner material shall be free of organic debris, frozen material, rubbish, construction debris, and other deleterious material. Any soil containing unacceptable material shall be removed and discarded in the permanent stockpile, placed in accordance with Section 02315, FILL AND BACKFILL.

Moisture Conditioning: The moisture content of the admix liner shall be uniform throughout each lift prior to and during compaction of the material. If the moisture content of a lift of compacted admix liner falls below the acceptable limit during placement operations, the Construction General Contractor shall moisture condition the dry soil and re-compact the lift prior to placement of additional lifts. If the moisture content of a lift of compacted soil exceeds the acceptable limit due to precipitation or over watering, the Construction General Contractor, before placement of additional lifts, shall either allow the wet soil to dry back or remove the wet soil. If the admix liner material cannot be conditioned to meet the placement specifications, the material shall be removed and replaced with new admix liner.

When the final lift of admix liner placement will be interrupted for more than a few hours or when precipitation is imminent, as determined by the Contractor's Site Superintendent, the lift surface shall be sealed with a smooth drum roller to prevent excessive moisture infiltration. This surface shall be scarified with a rotovator, or other equivalent equipment, immediately prior to resuming soil placement. The Construction General Contractor shall verify that existing moisture content is within the range specified in Article ADMIX LINER PLACEMENT AND COMPACTION, prior to resumption of soil placement activities.

Placement Equipment: The Construction General Contractor shall place layers of the admix liner to form a continuous monolithic material. All admix liner shall be placed and compacted with a self-propelled pegfoot or padfoot roller compactor having a minimum operating weight of 68,000 pounds. Smaller compaction equipment may be used in limited areas as necessary provided that the required moisture/ density, lift bonding, and hydraulic conductivity can be achieved. Hydraulic conductivity performance specification for the admix liner will be verified in areas where the lighter equipment is used. Hauling and spreading equipment will not be considered as compaction equipment. The compactor feet shall be sufficiently long to knead (bond) new lifts into previously placed lifts. The feet shall be kept free of large amounts of dried soil that might restrict foot penetration or become incorporated into the soil lift. The top of each lift may be scarified with a rotovator, or other equivalent equipment or procedures, prior to placing the subsequent lift. The final lift of admix liner may be compacted with a smooth drum roller provided that all other requirements are met.

Provide a smooth soil surface on the final lift prior to placement of the HDPE geomembrane as specified in Article SURFACE FINISHING.

Tie-in Areas: Where new admix liner is tied in to existing admix of a previous day's placement, any areas of the existing admix which are soft, cracked, or otherwise unsuitable shall be removed until acceptable material is exposed. Where new admix will be placed, the surface of the existing admix liner shall be scarified and moisture conditioned as described in this section. New admix liner shall be placed in accordance with the requirements of this section and shall be thoroughly kneaded into the existing admix liner to form a monolithic mass free of seams or other discontinuities.

Placement Method: Admix liner may be placed on the sideslopes in either horizontal lifts (along the contour) or in lifts parallel to the slope (up and down the slope). If admix liner is placed parallel to the slope, compaction equipment shall not spin their wheels or in any other way disturb the previously placed lifts. If this occurs, the Construction General Contractor shall place all of the admix liner in horizontal lifts.

Restrictions: Production, mixing, and stockpiling of admix or native clay soil shall be restricted to the area shown on the Drawings or within the Phase I footprint as approved by the Construction Manager.

SURFACE FINISHING:

The surface of the admix liner shall be trimmed to the design grades and tolerances as shown on the Drawings. The surface of the admix liner shall be rolled with a smooth-drum roller to remove all ridges and surface irregularities as specified in Section 02319, SUBGRADE PREPARATION. All wheel ruts in excess of depths specified in Section 02319, SUBGRADE PREPARATION, on the surface of the admix liner shall be repaired by the Construction General Contractor prior to placement of the geomembrane. Acceptable methods for repair of the admix liner are specified in Article REPAIR OF ADMIX LINER.

MAINTENANCE:

The Construction General Contractor shall maintain the admix liner surface in a condition suitable for geomembrane installation until the surface is covered. The admix liner shall be protected from desiccation or excessive moisture. This may be accomplished by periodic watering, exclusion of traffic, placement of a temporary removable plastic cover, or other methods. Desiccation cracks larger than 1 inch deep or 0.25 inch wide shall be excavated to the full depth of the crack and repaired as specified in Article REPAIR OF ADMIX LINER. In the event that the geomembrane cannot be installed within 12 hours after placement of the final admix liner lift, the final lift of admix liner shall be constructed 4 to 6 inches thicker than required and cut to finish grade immediately before geomembrane deployment.

The Construction General Contractor shall take measures to prevent the admix liner from freezing. Lifts of admix liner shall not be placed on frozen surfaces. Geomembrane shall not be placed on a surface, which is frozen or has been frozen and thawed until directed by the Construction Manager and the CQA Certifying Engineer.

REPAIR OF ADMIX LINER:

The Construction General Contractor shall repair the surface of any areas identified to be out of tolerance. The size of the repair area shall be as required to remove and/or repair defective areas of the admix liner. Repair as follows:

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

Alternative methods for repair of the admix liner will be allowed if submitted by the Construction General Contractor and approved by the Engineer and Construction Manager.

Construction General Contractor will repair small holes (up to a maximum 6-inch diameter) resulting from sampling and other CQA activities. Such holes shall be repaired by backfilling with admix liner or powdered bentonite material in lifts of no more than 2-inch thickness and hand tamping with a steel rod or other suitable device to firmly compact each lift.

CONSTRUCTION QUALITY ASSURANCE AND ACCEPTANCE:

Testing and criteria for admix liner acceptance is provided in the CQA Plan, which is made part of these Specifications by reference.

END OF SECTION 02666

SECTION 02667-GEOSYNTHETIC CLAY LINER (GCL) Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
ASTM D5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liner
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners

DESCRIPTION:

The Work includes supply and installation of geosynthetic clay liners (GCLs) for the landfill lining system as shown on the Drawings.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the materials proposed for use comply with the requirements of these Specifications.

Submit manufacturer's quality control test results, written properties certification guarantee, and QC certificates, as specified in PART 2-PRODUCTS.

CONSTRUCTION QUALITY ASSURANCE (CQA):

Quality assurance procedures are presented in the CQA Plan. CQA Plan requirements are discussed in Section 02661, GEOMEMBRANES. The Construction General Contractor shall accommodate all quality

assurance activities described herein and in the Construction Quality Assurance Plan (CQA Plan) for this project.

Prior to placing any materials over the installed GCL, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA CONFORMANCE TESTING:

Prior to deployment of the GCL, CQA personnel will remove samples and forward them to an approved geosynthetics laboratory for testing to document conformance to both the design specifications and the list of guaranteed properties. Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 50,000 square feet, whichever results in the greater number of tests. Samples shall be taken from any portion of the roll that has not been damaged. Unless otherwise specified, samples shall be 3 feet long by the roll width. The machine direction shall be marked on the samples with an arrow.

As a minimum, the following tests shall be performed on GCL:

1. Bentonite Swell Index: ASTM D5890.
2. GCL Index Flux: ASTM D5887.
3. Bentonite Mass per Unit Area: ASTM D5993.

The CQA Certifying Engineer shall be allowed to remove samples of GCL for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

PART 2 – PRODUCTS

GCL:

GCL shall be BENTOMAT(R) DN as manufactured by Colloid Environmental Technologies Co. (CETCO), Arlington Heights, IL; or Bentofix NWL as manufactured by GSE Lining Systems, Houston, TX; or approved equal, and shall meet the following requirements:

Property	**Requirement**	**Test Method**
Bentonite Mass/Area, lb/sq ft at 0% moisture content, MinARV	0.75	ASTM D5993
Bentonite Fluid Loss, mL, MaxARV	18	ASTM D5891
Bentonite Swell Index, mL/2g, MinARV	24	ASTM D5890
Grab Strength, lb, Tested Dry, MinARV	150	ASTM D4632
Peel Strength, lb, Tested Dry, MinARV	15	ASTM D4632
Index Flux, $m^3/m^2/sec$, MaxARV	$1x10^{-8}$	ASTM D5887
• 2 psi Water Head Pressure		
• 5 psi Effective Confining Pressure		
Permeability with Water, cm/sec, MaxARV	$5x10^{-9}$	ASTM D5084
• 2 psi Water Head Pressure		
• 5 psi Effective Confining Pressure		
Finished GCL Roll Width, Feet, MinARV	14	Linear Measurement
Finished GCL Roll Length, Feet, MinARV	150	Linear Measurement

The bentonite in the GCL shall be a sodium montmorillonite clay.

The GCL shall be manufactured so that the bentonite shall be continuously contained throughout the GCL and to support the geotextiles so that no displacement of the bentonite occurs when the material is unrolled, moved, cut, torn, or punctured. GCL products that utilize an alternate edge system with grooves cut in seam overlap areas are permitted subject to approval of the Engineer. Any adhesive used shall be inert, nontoxic, and water-soluble. GCL materials made without the use of adhesives shall be stabilized to contain the granular bentonite by a process such as needle punching or stitching through the top and bottom layers of geotextile and the bentonite.

Encapsulating geotextile materials shall be polypropylene, consisting of two nonwoven geotextile components, which are needle-punched together. The nonwoven components of the GCL shall have a nominal mass per unit area of 6 ounces per square yard needle-punched geotextile.

Quality control testing shall be carried out by the manufacturer to demonstrate that the GCL meets the specifications in this section. Tests shall be conducted on each production lot of GCL or every 50,000 square feet, whichever results in the greater number of tests.

The manufacturer shall provide a written guarantee that the GCL has the properties listed on the specification sheet.

The GCL manufacturer shall provide a quality control certification that the GCL has the properties listed on the specification sheet for each roll of GCL shipped to the project site. The quality control certificate shall be signed by a responsible party employed by the manufacturer, such as the production manager. The quality control certificate shall include:

1. Roll numbers and production lot identification.
2. Results of manufacturer quality control tests.
3. Results of bentonite supplier quality control tests for bentonite used in GCL production.

ACCESSORY BENTONITE:

Accessory bentonite for seaming shall be as recommended by the GCL manufacturer.

TRANSPORTATION, HANDLING, AND STORAGE:

Transportation of the GCL shall be the responsibility of the manufacturer, and the Construction General Contractor. All handling on site shall be the responsibility of the Construction General Contractor.

Upon delivery at the site, the Construction General Contractor shall observe the surfaces of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Construction General Contractor will determine:

Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.

Rolls that are not properly labeled. No unlabelled rolls shall be used for any application. Unlabelled rolls shall be removed from the site and replaced at the Construction General Contractor's expense.

The Construction General Contractor shall be responsible for the storage of the GCL onsite. The Construction General Contractor shall provide storage space in a location as shown on the Drawings or as approved by the Construction Manager such that on-site transportation and handling are optimized to the extent possible. Storage space shall be protected from theft, vandalism, passage of vehicles, etc. Stored GCLs shall be protected from moisture and other damaging conditions in accordance with the manufacturer's recommendations.

PART 3 – EXECUTION

GENERAL:

Install GCLs at the locations, lines, and grades shown on the Drawings. All GCLs shall be installed in accordance with these Specifications.

Materials and Work, which fail to meet the requirements of these Specifications, shall be removed and disposed of at the Construction General Contractor's expense. This includes GCL rolls that are not labeled or where the label has deteriorated to the point of being illegible.

HANDLING AND PLACEMENT:

The Construction General Contractor shall handle and deploy all GCLs in such a manner as to ensure that they are not damaged.

SURFACE PREPARATION – PRIMARY GCL:

For the IDF project, primary GCL will be deployed over the CDN surface. Primary GCL shall be placed over a firm, unyielding surface. Wrinkle height in the underlying LDSCDN shall be minimized as to allow primary GCL deployment on a flat unyielding surface. Maximum wrinkle height for geosynthetics is specified in Section 02661, GEOMEMBRANES.

SURFACE PREPARATION – SECONDARY GCL:

As specified in Section 02319, SUBGRADE PREPARATION.

DEPLOYMENT:

GCL shall be deployed so that seams run up and down (not across) the slope.

Prior to placement of cover material over the GCL and HDPE geomembrane, the moisture content of the bentonite component of the GCL shall not exceed 100 percent. Only areas of GCL suspected of exposure to excessive moisture, in the judgment of the CQA Certifying Engineer, shall be sampled for moisture content. GCL panels with bentonite component moisture content greater than 100 percent shall be removed and replaced at Construction General Contractor's expense, regardless of the source of moisture, including adsorption from subgrade soil and/or condensation under the HDPE geomembrane or temporary plastic cover.

Any wrinkles in excess of the maximum wrinkle height specified in Section 02661, GEOMEMBRANES, shall be reduced to below specified height by adjusting and smoothing the GCL after placement.

GCL shall not be deployed during precipitation or in the presence of moisture, ponded water, snow, or in other situations that could cause premature hydration of the bentonite. Any GCL that hydrates prematurely shall be removed and replaced at the Construction General Contractor’s expense.

The panels shall be placed to provide an overlap of 6 inches on longitudinal (edge of roll) seams, regardless of slope steepness. The panels shall be placed to provide an overlap of 24 inches on transverse (end of roll) seams for slopes flatter than 6H:1V. No transverse seams shall be allowed on slopes 6H:1V and steeper.

No more GCL shall be deployed than can be covered with geomembrane or other protective layer the same day.

Provide protection from wind uplift as necessary using sandbags or other method that will not damage the GCL.

OVERLAPPING GCL PANELS:

Overlap marks 6 inches from the panel edge shall be marked longitudinally on the GCL to assist in obtaining the proper overlap.

Prior to lapping, remove all dirt, gravel, or other debris from the overlap area. Apply 1/4 pound of accessory per linear foot of seam. Lap areas that have been contaminated by soil and/or sand shall receive additional accessory bentonite in the amount of 1/4 pound per linear foot evenly spread across the longitudinal seam area. GCL products with alternate edge treatment system with grooves cut in the seam overlap area that eliminate the requirement for accessory bentonite, are permitted for edge of roll seams with prior approval by the Engineer. Accessory bentonite shall be required for end of roll seams.

End of roll overlap on slopes less than 6H:1V shall be shingled so that the direction of flow is from the top panel onto the bottom panel. On slopes 6H:1V and steeper, the panels shall be placed with the long dimension (length) continuous from the crest to the toe and the upper end anchored in a trench with soil backfill as shown on the Drawings.

REPAIRS:

Replace or repair damaged or hydrated areas of GCL.

Place a patch of GCL that extends at least 12 inches beyond the edges of the damaged area in all directions.

Overlap areas shall conform to requirements for seams described above.

PLACEMENT OF OVERLYING MATERIALS ON GEOSYNTHETIC CLAY LINING:

The GCL shall be completely covered with HDPE geomembrane or temporary plastic cover and protected at the end of each shift or workday. The Construction General Contractor shall be fully responsible to protect the GCL from damage, shrinkage, or prehydration and shall replace all affected materials at the Construction General Contractor's sole expense.

To prevent premature hydration or shrinkage in hot weather, only the amount of GCL that can be anchored, inspected, repaired, and covered with HDPE geomembrane or temporary plastic cover in the same day shall be installed.

Equipment used to install the overlying materials shall not operate directly on the GCL.

Construction General Contractor shall use a "rub sheet" of smooth HDPE geomembrane between the GCL and textured HDPE geomembrane to prevent damage to the GCL while maneuvering the textured HDPE geomembrane into position for seaming. Construction General Contractor shall develop method(s) of removing rub sheet that, after maneuvering textured HDPE geomembrane into place, prevents damage to toe underlying GCL.

Overlying materials shall be placed over the GCL and HDPE geomembrane as specified in Section 02661, GEOMEMBRANES.

END OF SECTION 02667

SECTION 02920 – RECLAMATION AND REVEGETATION

Sched. A & B

PART 1 – GENERAL

SUMMARY:

This section includes, but is not limited to, stabilization measures to prevent wind and water caused erosion of areas disturbed by the construction.

REFERENCES:

ASTM INTERNATIONAL (ASTM)

ASTM D586 Standard Test Method for Ash in Pulp, Paper, and Paper Products

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for procedures.

Manufacturer's technical data and installation recommendations for erosion control matting, including type and spacing of anchorage devices.

Manufacturer's written certification that wood fiber mulch product contains less than 250 parts per million boron, is nontoxic to plant and animal life, and satisfies the specified organic matter content as determined by ASTM D586.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Tackifier and Mulch: Submit manufacturer's information and/or product data sheets for the tackifier selected for use on this project. Include confirmation of the application rate, which will be used. Submit Material Safety Data Sheets for the tackifier and any dye used in the tackifier and mulch application. Installation warranty.

PART 2 – PRODUCTS

MATERIALS:

Topsoil: Strippings that are free from toxic minerals, noxious weeds, and other objectionable material shall be used for topsoil in accordance with Section 02200, SITE PREPARATION. Vegetation shall be removed during clearing and grubbing in accordance with Section 02200, SITE PREPARATION. The removed vegetation, other than noxious weeds, shall be reduced to pieces that are no larger than 1 inch in any dimension and shall be incorporated uniformly into the strippings. Large clods, hard lumps, rocks 2 inches in diameter and larger, and litter shall be removed from the topsoil.

Topsoil shall be stockpiled in accordance with Section 02200, SITE PREPARATION.

Grass Seed: Grass seed shall be crested wheatgrass var. Nordan. The grass seed shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification," latest edition.

Seed shall be furnished in standard containers on which shall be shown the following information:

Common name of seed.
Lot number.
Net weight.
Percentage of purity.
Percentage of germination.
Percentage of weed seed content and inert material clearly marked in accordance with applicable state and federal laws.

The maximum allowable noxious weed percentage (by weight) is 0.5 percent. The maximum allowable inert percentage is 7 percent.

Upon request, the Construction General Contractor shall furnish to the Construction Manager duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months before the date of delivery on the project. Seed, which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

Fertilizer: Fertilizer shall be either fertilizer Type A or fertilizer Type B.

Fertilizer Type A shall be an organic product developed from byproducts of the manufacture of various antibiotics, enzymes, and proteins. Fertilizer Type A shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 7-2-3 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type A shall be sterilized and weed free. Fertilizer Type A shall be supplied in dried, granulated form with the dried weight, contents, and chemical analysis clearly marked on each bag. One suggested product name for fertilizer Type A is Biosol Mix, Rocky Mountain Bio-Products, Inc., Edwards, CO.

Fertilizer Type B shall be an organic product manufactured from seedmeal (60 percent), protein-derived, and fortified with calcium-rich (300 pounds per ton) composted chicken manure. Fertilizer Type B shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 6-4-1 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type B shall be biodegradable, nonpolluting, nonvolatile, nontoxic, sterilized and weed free, and contain no heavy metals or salts. Fertilizer Type B shall be supplied in dried, pelletized form with the dried weight, contents, and chemical analysis clearly marked on each container. One suggested product name for fertilizer Type B is Fertile-Fibers Nutrimulch™, Quattro Environmental, Coronado, CA.

Wood Fiber Mulch: Wood fiber mulch shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. The fibers shall not contain any rock, metal, or plastic. It shall be suitable for hydromulching and shall be treated with a nontoxic green dye to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture. The product shall contain less than 250 parts per million boron and shall be nontoxic to plant and animal life. The organic matter content shall be at least 93 percent on any oven-dry basis as determined by ASTM D586. The moisture content shall be no more than 15 percent as determined by oven-dried weight. Each package of the wood fiber mulch shall be marked by the manufacturer to show the dried weight. Wood fiber mulch shall be added to the tackifier at the rate of 1,500 pounds per acre minimum.

Straw Mulch: Straw mulch shall be air dried straw free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.

Tackifier: The tackifier shall be an organic guar tackifier derived form natural organic plant sources or a 100 percent polyacrylamide. The tackifier used shall contain no growth or germination inhibiting materials. The guar based tackifier shall be applied at a rate of 60 pounds per acre minimum. If polyacrylamide is used as the tackifier instead of guar, it shall be applied at 5 pounds per acre minimum.

Erosion Control Matting: Erosion control matting shall be used to prevent erosion of soil due primarily to wind. Erosion control matting shall be a long-life dense matting composed of nylon fiber, polyolefin fiber, or polyester fibers. The matting shall be of a consistent thickness with the fiber evenly distributed over the entire area of the matting. The fibers shall be encased between two layers of heavy polypropylene or polyolefin netting. The fibers and the netting shall be stitched top to bottom to form a three-dimensional matrix using polyester or polyolefin thread. All components of the erosion control matting shall be stabilized against ultraviolet degradation and inert to chemicals normally encountered in a natural soil environment. The erosion control matting shall have a minimum thickness of 0.5 inch and a minimum weight of 10 ounces per square yard. Three suggested product names for erosion control matting are Landlok ECRM 450, Synthetic Industries, Chattanooga, TN; P300, North American Green, Evansville, IN; and Recylex TRM, American Excelsior Company, Arlington, TX.

Anchorage devices for erosion control matting shall be as recommended by the manufacturer of the erosion control matting and as approved by the Construction Manager.

Soil Stabilization Cover: Soil stabilization cover shall be applied on the finished grade inside side slopes of the Phase I excavation to reduce wind and water caused erosion. Soil stabilization cover shall be a waterborne copolymer emulsion consisting of nonflammable concentrated PVA liquid copolymer with acrylic base having 60 percent solids. On drying the soil stabilization cover shall from a colorless transparent net-like film. Such film shall have permeability to allow exchange of air and moisture and have an effective life of at least 1 year. The copolymer shall not re-emulsify when cured. The liquid copolymer emulsion shall be nontoxic to plants and animals. One suggested product name for soil stabilization cover is Marloc, Reclamare Company, Des Moines, WA.

PART 3 – EXECUTION

PLACING TOPSOIL:

A 6-inch thick layer of topsoil, or as otherwise ordered by the Construction Manager, shall be evenly spread over all areas where material has either been excavated from or has been placed in that are to be seeded, including all borrow areas and permanent stockpiles.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Construction Manager in a condition detrimental to the work.

Upon physical completion of the work, remaining topsoil shall be stockpiled at the location shown on the Drawings. The permanent topsoil stockpile shall than be seeded, fertilized, and mulched.

SEEDING, FERTILIZING, AND MULCHING:

General: Areas to be seeded, fertilized, and mulched are indicated on the Drawings. No seeding, fertilizing, and mulching shall be done within the Phase I excavation, unless directed otherwise by the Construction Manager. Areas to be seeded, fertilized, and mulched include at a minimum the east and

west infiltration areas, the berm and ditch located south of the Phase I excavation, soil stockpiles that will remain after the completion of the construction, and borrow areas. Other areas outside of the Phase I excavation that are disturbed by the construction and are not otherwise stabilized shall be seeded, fertilized, and mulched as directed by the Construction Manager.

Season of Work: Seeding shall be done between September 1 and March 1. Specific ideal seeding times within this window shall be as required for proper seedbed preparation.

Weed Control: Areas to be seeded shall be maintained reasonably free of weeds. Weeds shall be kept from going to seed.

Seedbed Preparation: Soil shall be tilled to a minimum depth of 6 inches. The seedbed shall be firm below seeding depth and well pulverized and loose on top. It shall be free of clods and weeds. Tillage shall leave cross-slope furrows. Seedbed preparation shall not be performed when soil conditions are not suitable for tilling: too dry, too wet, frozen, etc.

Areas to be seeded that have not either had material excavated from them or placed in them shall not receive any seedbed preparation unless directed otherwise by the Construction Manager. The seedbed preparation would destroy any existing soil crust. Existing soil crust provides erosion protection.

Application of Seed and Fertilizer: Seeding and fertilizing shall be done closely following seedbed preparation and shall not be done during windy weather or when the ground is frozen or excessively wet. The Construction General Contractor shall notify the Construction Manager not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Construction Manager's approval, seeding of the approved areas shall begin immediately.

Seed and fertilizer shall be applied by one of the following methods:

Hydroseeding: Use a hydroseeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydroseeder tank no more than 1 hour prior to application.

Hand Broadcasting: Apply fertilizer first. The seed shall be incorporated into the top 1/4 inch of soil by hand raking or other method that is approved by the Construction Manager.

Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Seed shall be applied at a rate of 10 to 12 pounds pure live seed per acre. Fertilizer shall be applied at a rate of 1,000 pounds per acre.

Mulching: Straw mulch shall be evenly applied at a rate of 1.0 ton per acre within 48 hours after seeding. Mulching shall not be performed when wind interferes with mulch placement. Distribution of straw mulch material shall be by means of a mulch spreader that utilizes forced air to blow mulch material on the seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Straw mulch may be spread by hand over areas that were seeded by hand. Straw mulch shall be crimped into the soil to a depth of 2 inches and with no more than one pass of the equipment.

In areas where it is not possible to crimp the straw mulch into the soil, tackifier shall be applied over the straw mulch. The method of application for tackifier shall be in accordance with the manufacturer's instructions. The tackifier application rate shall be as specified herein. Tackifier shall be sprayed over mulch, seed, and fertilizer. The Construction Manager shall indicate which areas (if any) shall have the straw mulch held down with tackifier.

Mulching can be accomplished by either hydromulching with wood fiber mulch, or by mulch spreader (or by hand) with straw mulch. Using hydromulching, wood fiber mulch will be added to the tackifier at the rate of 1,500 pounds per acre, in addition to the mulch used as tracer for hydroseeding.

Protection: Traffic over seeded areas shall be prohibited.

Installation Warranty: The warranty period for seeding, fertilizing, and mulching will begin upon the date of acceptance of the completed installation. The installation shall be considered complete by the Construction Manager upon satisfactory completion of the initial inspection, which is described below. Acceptance will be certified in writing by the Construction Manager.

Seeded areas shall be guaranteed by the Construction General Contractor for a period of 1 year. Mulch coverage will be used to evaluate the materials and workmanship of the application of seed, fertilizer, and mulch. Seed, fertilizer, and mulch will be reapplied one time only as directed by the Construction Manager at the Construction General Contractor's expense in areas where the coverage does not meet the following criteria. Three inspections of mulch coverage will occur:

Initial inspection will occur between 1 to 3 business days following completion of the installation for the purposed of Construction Manager acceptance. Mulch coverage must equal 100 percent of the area over which it was spread before Construction Manager acceptance will occur.

Mulch coverage will be inspected 60 days after Construction Manager acceptance at which time mulch coverage must equal 100 percent of the area over which it was spread.

A final inspection will occur 30 days prior to the end of the warranty period. At this time, mulch coverage must equal at least 80 percent of the area over which it was spread.

PLACING EROSION CONTROL MATTING:

Erosion control matting shall be installed in the locations shown on the Plans and as directed by the Construction Manager. The erosion control matting shall be securely anchored to resist the wind. The erosion control matting shall be installed following the manufacturer's recommendations and the following minimum requirements. Where more than one strip of erosion control matting is required, it shall overlap the adjacent matting a minimum of 6 inches. The ends of the erosion control matting shall overlap a minimum of 6 inches with the uphill section on top.

PLACING SOIL STABILIZATION COVER:

Soil stabilization cover shall be applied with hydroseeding equipment in two passes of opposite directions. Copolymer shall be applied at a minimum rate of 200 gallons per acre; dilution rate for copolymer and water shall be per the manufacturer's recommendation. Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Soil stabilization cover shall be applied when adequate weather conditions for proper curing, as determined by the manufacturer, are anticipated. The Construction General Contractor shall apply soil stabilization cover only to finish graded areas unless directed otherwise by Construction Manager.

END OF SECTION 02920

DIVISION 3–CONCRETE

SECTION 03301—CONCRETE Sched. A & B

PART 1 – GENERAL

WORK INCLUDED:

This section is a ready-mix concrete and reinforcing bar specification for concrete.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117	Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete for Buildings
ACI 305R	Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318/318R	Building Code Requirements for Reinforced Concrete
ACI 347	Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A185	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
ASTM A615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
ASTM C33	Standard Specification for Concrete Aggregates.
ASTM C39	Standard Test Methods for Compressive Strength of Cylindrical Concrete Specimens.
ASTM C94	Standard Specification for Ready-Mix Concrete.
ASTM C150	Standard Specification for Portland Cement.
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete.
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
ASTM C494	Standard Specification for Chemical Admixtures for Concrete.
ASTM C618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI	Manual of Standard Practice.

Recommended Practice for Placing Reinforcing Bars.

1997 UNIFORM BUILDING CODE (UBC)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Reinforcing steel in accordance with CRSI Manual of Standard Practice and ACI SP-66, Detailing Manual.

Curing compound data.

Complete data on the concrete mix, including aggregate gradations and admixtures, in accordance with ASTM C94.

Statement identifying aggregates reactivity.

Concrete mix design signed by a qualified mix designer that is a licensed professional engineer in the State of Washington.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Qualifications of independent qualified testing laboratory for concrete construction quality control.

Manufacturer's application instructions for curing compound.

Statement for batch plant currently certified by the National Ready Mixed Concrete Association. If batch plant cannot be certified, then Construction General Contractor shall demonstrate to the Construction Manager's satisfaction by providing additional testing as determined by the Construction Manager such that the concrete may be determined to be acceptable. These test results shall be submitted to Construction Manager.

Certification for proper functioning of concrete transport trucks including blades, drum rotators, counters, and other components. Certification shall be acceptable only for concrete batch plants certified by the National Ready Mixed Concrete Association. Batch plants that are not certified shall require concrete transport trucks to undergo independent assessment to the satisfaction of the Construction Manager.

Ready-mix delivery tickets for each truck in accordance with ASTM C94.

Concrete crack repair epoxy injection statement of qualifications for manufacturer's site representative, injector applicator, and injector pump operating technician. Submit only if crack repair is required.

Pour slip shall be required prior to any concrete placement to serve as a checklist between the Construction Manager and the Construction General Contractor. This checklist will be used to document Construction General Contractor's readiness for concrete placement. Pour slip form shall be provided to the Construction General Contractor from the Construction Manager.

Results of construction quality control testing.

ENVIRONMENTAL REQUIREMENTS:

Do not place concrete when the ambient temperature is below 40 degrees F or approaching 40 degrees F and air temperature less than 40 degrees F for the first 7 days, without special protection to keep concrete above 40 degrees F.

Do not use curing compound where solvents in the curing compounds are prohibited by state or federal air quality laws.

Form sealer shall be a ready-to-use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations.

PART 2 – PRODUCTS

FORM MATERIALS:

All formwork shall conform to the guidelines in ACI 347.

Forms for Exposed Finish Concrete: Provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete without visible bow or deflection:

Plywood shall comply with American Plywood Association, grade "EXT-DFPA PLYFORM" or better.

Forms for Unexposed Finish Concrete: Form concrete surfaces, which will be, unexposed in finished structure with plywood, lumber, or metal.

Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

Form Ties: Steel form ties with conical or spherical spreader insert that will leave no metal closer than 1 inch to concrete surface after tie ends are removed. Wire ties shall not be used.

Water stop ties shall be perpendicular to water stop and symmetrical about the center of tie and designed to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along the tie. Maximum spacing shall be 12 inches, and all corners shall be tied.

CONCRETE MATERIALS:

Portland Cement: Cement shall conform to ASTM C150, Type I-II. The cement shall contain no more than 0.60 percent by weight of alkalies calculated as ($Na_2O + 0.658\ K_2O$).

Pozzolans: Pozzolans (fly ash) shall conform to ASTM C618 Class C or Class F, except that the loss on ignition (LOI) shall be less than 2 percent.

Aggregate: Fine and coarse aggregate shall conform to ASTM C33. Maximum coarse aggregate size shall conform to ACI 318, paragraph 3.3.2. Unless otherwise specified, maximum aggregate size shall be 1-1/2 inches. Aggregate shall be nonpotentially reactive in accordance with ASTM C33, Appendix XI, paragraph X1.1.

Mixing Water: Potable having no pronounced taste or odor, and containing no deleterious materials.

Air-Entraining Agents (AEA): ASTM C260.

Water-Reducing Admixtures: If water-reducing admixtures are used, they shall conform to ASTM C494, Type A, and contain no more than 1 percent chloride ions.

Calcium Chloride: Calcium chloride is not permitted.

REINFORCING STEEL:

Deformed Bars: ASTM A615, Grade 60. Welding of reinforcing shall not be permitted.

Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in place. Use wire bar type supports complying with CRSI recommendations, or approved substitute. Use supports with sand plates or horizontal runners where base material will not support chair legs. Pumice blocks, adobe, bricks, rocks, etc. are not acceptable for rebar or wire mesh supports.

ANCILLARY MATERIALS:

Concrete Crack Repair Epoxy Injection Manufacturers:

Contech Group, Seattle, WA, or Portland, OR.
Sika Group, Lindhurst, NJ.
Euclid Chemical Co., Cleveland, OH.

Expansion Joint Filler: ASTM D994, 1/2 inch thick, or as shown.

Nonshrink Grout:

Color: To match concrete.

MANUFACTURERS AND PRODUCTS:

Master Builder Co., Cleveland, OH; Master Flow 928.
Euclid Chemical Co., Cleveland, OH; Hi-flow Grout.

Curing Compound:

Material: Water-based curing compound in accordance with ASTM C309, Type I or Type 1D, with additional requirement that the moisture loss not exceed 0.040 gram per centimeter squared per 72 hours.

Manufacturers and Products:

Master Builders Co.; Masterkure 200W.
Euclid Chemical Co.; Super Diamond Clear Vox.

Water Stop: Extruded elastomeric plastic compound with basic resin to be polyvinyl chloride.

Manufacturers and Products:

Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN, RB6-38H.
A. C. Horn, Inc., Beltsville, MD; Catalog No. CSP-162, Type 9 (6-inch by 3/8-inch).

Hydrophilic Water Stop:

Material shall be a non-bentonite hydrophilic rubber compound. Material shall be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.

Manufacturers and Products:

Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-K with Leakmaster LV-1 adhesive and sealant.

Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

Red Coloring for Electrical Duct Encasement: Commercial grade red iron oxide, 3 pounds per sack of cement.

CONCRETE SLAB COATING:

As specified in Section 09900, PAINT COATING SYSTEMS.

PROPORTIONING AND DESIGN OF MIXES:

Mix Design: Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 318 and 1997 UBC. The more stringent requirements of ACI 318 and 1997 UBC shall apply. Existing mix design test records shall be acceptable only if the facility is certified by National Ready Mixed Concrete Association. Uncertified concrete batch plant shall require testing from a qualified independent testing agency to develop the test and number of tests for an acceptable standard deviation to be developed.

Design mixes to provide normal weight concrete with the following specified 28-day compressive strengths, minimum, as indicated on drawings and schedules:

Class 30: 3,000 psi (non-structural concrete elements such as sidewalks, guard posts, fences, post and pole foundations, conduit encasement, and thrust blocks).

Class 40: 4,000 psi (structural concrete).

Class 50: 5,000 psi (truck loading pad).

See CONSTRUCTION QUALITY CONTROL of this specification for acceptance criteria.

Concrete mixes incorporating pozzolan (fly ash) shall contain a minimum of 15 percent fly ash by weight and the maximum 25 percent fly ash of the total cementitious materials.

Class 40 and Class 50 air content shall be 4 to 6 percent when tested in accordance with ASTM C231.

Follow manufacturer’s recommendations for addition of water reducers.

Class 40 and Class 50: Concrete shall be air-entrained and shall incorporate the usage of high-range water reducer. Concrete mix design shall contain fly ash. Add air entraining agent (AEA) at the manufacturer's prescribed rate to result in concrete at point of placement having air content complying with ACI 301.

Unless specifically stated otherwise, water-cement ratio (or water-cement plus fly ash ratio) shall control amount of total water added to concrete as follows:

Water-Cement Ratio Coarse Aggregate Size	Maximum W/C Ratio w/Superplasticizer	Maximum W/C Ratio w/o Superplasticizer
1-1/2"	0.40	0.45
1"	0.40	0.45
3/4"	0.40	0.45

Slump Range at Site(Class 40 and Class 50):

4-1/2 inches minimum, 8 inches maximum for concrete with a high range water reducing admixture.
3 inches minimum and 5 inches maximum for concrete without high range water reducing admixture.

Combined Aggregate Gradation:

Select one of the gradations shown in the following table.

Combined Gradation Limits: Limits shown are for coarse aggregates and fine aggregates mixed together (combined).

	Combined Gradation Percentage Passing		
Sieve Sizes	**1-1/2" Max.**	**1" Max.**	**3/4" Max.**
2"	- 100	-	-
1-1/2"	95 - 100	- 100	-
1"	65 - 85	90 - 100	- 100
3/4"	55 - 75	70 - 90	92 – 100
1/2"	-	-	68 – 86
3/8"	40 - 55	45 - 65	57 – 74
No. 4	30 - 45	31 - 47	38 – 57
No. 8	23 - 38	23 - 40	28 – 46
No. 16	16 - 30	17 - 35	20 – 36
No. 30	10 - 20	10 - 23	14 – 25
No. 50	4 - 10	2 - 10	5 – 14
No. 100	0 - 3	0 - 3	0 – 5
No. 200	0 - 2	0 - 2	0 – 2

Minimum Cement Content (or Combined Cement Plus Fly Ash Content When Fly Ash is Used):

517 pounds per cubic yard for concrete with 1-1/2-inch maximum size aggregate.
540 pounds per cubic yard for 1-inch maximum size aggregate.
564 pounds per cubic yard for 3/4-inch maximum size aggregate.

Increase cement content or combined cement plus fly ash content, as required to meet strength requirements and water-cement ratio.

MIXING AND DELIVERY (CLASS 40 AND CLASS 50):

The manufacture and delivery of all concrete shall conform to ASTM C94 except as modified herein. Hand-mixed concrete is prohibited.

When concrete arrives at the jobsite with slump below that suitable for placing, as indicated by the Specification, water may be added only if the maximum permissible water-cement ratio and the maximum permissible slump is not exceeded. Any water thus added to bring the slump within required limits shall be injected in such a manner that uniformity requirements are met. Water shall be incorporated by additional mixing equal to at least half of the total mixing required or 30 drum

revolutions at rated mixing speed, whichever is more. Additional AEA may be introduced during this mixing period if necessary to meet Specifications. Neither water nor AEA shall be added to the batch at any later time.

Concrete uniformity shall meet the requirements of ASTM C94 except as modified herein. After final mixing is complete, visible lumps, nonconformance to uniformity requirements, or failure to meet specified slump, entrained air, and temperature requirements shall be considered cause for rejecting the remainder of the load. In addition, failure of the ready-mix truck drum to meet uniformity requirements will be deemed cause for rejection of the mixing equipment until adequate repairs have been made.

Discharge of the concrete shall be completed within 1-1/2 hours, or before the drum has revolved 300 revolutions, whichever comes first, after the introduction of mixing water to the cement and aggregates unless special approved time delay admixtures are used. Coordinate time delay admixture information with manufacturer and Construction Manager prior to placing concrete. In hot weather or under conditions contributing to quick stiffening of the concrete a time limit less than 1-1/2 hours may be designated by the Construction General Contractor.

Additional high-range water-reducing admixtures (superplasticizer) may be added to the mixer at the jobsite using manufacturer-approved dispensing when unexpected delays cause too great of slump loss.

Concrete that is rejected for failure to meet any of the above requirements will be evaluated by the Engineer and may be removed and replaced at the expense of the Construction General Contractor.

Hot or Cold Weather Concreting: Methods and means of batching, mixing, and delivery of concrete in hot or cold weather shall comply with ACI 305R or ACI 306.1.

PART 3 – EXECUTION

FORMWORK:

Unless otherwise shown on the drawings, all forms shall be straight and plumb, rigid and mortar tight. All forms shall be braced, tied, and supported sufficiently to maintain their required position during and after the placing of concrete. Joints shall be sufficiently tight to prevent mortar leakage. Where shown on the Drawings, embedded items shall be placed in forms to shape edges or surfaces to that of the concrete members. All formwork shall conform to the guidelines in ACI 347.

All exposed corners of concrete shall be chamfered 3/4 inch.

Form Removal:

Formwork Not Supporting Weight of Concrete: This formwork may be removed after cumulatively curing at not less than 50 degrees F for 32 hours after placing concrete, provided concrete is sufficiently hard not to be damaged by form removal or subsequent operations. Curing must then continue through the minimum curing period.

Formwork Supporting Weight of Concrete: This formwork may not be removed until concrete has attained its 28-day design compressive strength, except as permitted under "Early Loading of New Concrete" as specified below.

Early Loading of New Concrete: Early loading of concrete structures shall comply with requirements of ACI 318, Section 6.2. When construction loading is proposed before concrete has achieved its 28-day design strength, structural calculations and concrete strength test data shall be submitted and approved by the Construction Manager prior to loading.

Form Sealer:

Material: Surface sealer will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces when applied to forms.

Manufacturers and Products:

Master Builders, Inc.; Rheofinish.
Burke Chemicals; Burke Release No. 1.

PLACING REINFORCING STEEL:

Unless otherwise specified, place reinforcing steel in accordance with CRSI Recommended Practice for Placing Reinforcing Bars and ACI 301.

SPLICING:

Follow ACI 318/318R.
Use lap splices, unless otherwise shown or permitted in writing by Engineer.
Stagger splices in adjacent bars where indicated.

PLACING CONCRETE:

Place concrete in accordance with ACI 301.

Prior to placing concrete, remove water from excavation and debris and foreign material from forms. Check reinforcing steel for proper placement and correct discrepancies.

Before depositing new concrete on old concrete, clean surface using sandblast or bushhammer or other mechanical means to obtain a 1/4-inch rough profile, and pour a cement-sand grout to minimum depth of 1/2-inch over the surface. Proportion 1 part cement to 2.5 parts sand by weight.

Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 2 feet deep. Place within 1-1/2 hours after adding cement to mix.

Eight feet maximum vertical drop to final placement, when not guided with chutes or other devices to prevent segregation due to impact with reinforcing.

Concrete shall be placed near its final location to avoid segregation.

Cold Weather Placing: Protect concrete work from damage or reduced strength, which could be caused by frost, freezing, or low temperatures, in compliance with ACI 306.1 and as specified herein. Minimum concrete temperature as placed and maintained shall be 55 degrees F, or as required by ACI-306.1, Table 3.2.1.

Hot Weather Placing: When hot weather conditions that would seriously impair quality and strength of concrete exist, place concrete in compliance with ACI 305 and as specified herein:

Cool mixing drum and/or ingredients before mixing to maintain concrete temperature below 90 degrees F at time of placement.

COMPACTION:

Vibrate concrete as follows:

Apply approved vibrator at points spaced not farther apart than vibrator's effective radius.
Apply close enough to forms to vibrate surface effectively but not damage form surfaces.
Vibrate until concrete becomes uniformly plastic.
Vibrator must penetrate fresh placed concrete and into previous layer of fresh concrete below.
Vibrator shall not be used to move concrete.

CONSTRUCTION JOINTS:

Locate as shown or as approved.

Provide waterstops in construction joints as indicated and with other Construction General Contractor-required construction joints that is approved by the Engineer.

Maximum Spacing Between Construction Joints: 40 feet.

INSTALLATION OF EMBEDDED ITEMS:

Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by cast-in-place concrete. Secure all such items firmly in position.

FINISHING:

Floor Slabs and Tops of Walls:

Finish slabs to grades shown on Drawings.

Screed surfaces to true level planes.

After initial water has been absorbed, float with wood float and trowel with steel trowel to smooth finish free from trowel marks.

Do not absorb wet spots with neat cement.

Unexposed Slab Surfaces: Screed to true surface, bull float with wood float, and wood trowel to seal surface. Finish surfaces to grades shown on Drawings.

Tolerances: Floors shall not vary from level or true plane more than 1/4-inch (plus or minus) in 10 feet when measured with a straightedge. Floors shall conform to grades shown on Drawings. Conform to ACI 117.

Exterior Slabs and Sidewalks:

Bull float with wood float, wood trowel, and lightly trowel with steel trowel.
Finish with broom to obtain nonskid surface.
Finish exposed edges with steel edging tool.
Mark walks transversely at 5-foot intervals with jointing tool.

FINISHING AND PATCHING FORMED SURFACES:

Smooth Form Finish (SmFm): Provide as-cast smooth form finish for formed concrete surfaces that are exposed to view, or that are covered with a coating material applied directly to concrete, or a covering material bonded to concrete such as waterproofing, damp proofing, painting, or other similar system.

Produce smooth form finish (SmFm) by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

Cut out honeycombed and defective areas.

Cut edges perpendicular to surface at least 1 inch deep. Do not feather edges. Soak area with water for 24 hours.

Patch with nonshrink grout.

Finish surfaces to match adjacent concrete.

Keep patches damp for minimum 7 days or spray with curing compound to minimize shrinking.

Fill form tie holes with Nonshrink Grout.

CONCRETE PROTECTION AND CURING:

General: Protect freshly placed concrete from injurious action by sun, rain, wind, flowing water, mechanical injury, and premature drying for not less than seven (7) consecutive days after placement.

Protect concrete against damage from frost or freezing for a minimum of 3 days. Provisions of ACI 306.1 shall apply for cold weather unless otherwise specified.

Remove and replace concrete damaged by freezing.

Curing Methods: Perform curing of concrete by one or more of the following methods:

Moist Curing: Cover concrete surfaces with moisture retaining cover for curing period. Exposed horizontal concrete surfaces may be covered with sand or other approved material and kept wet for the required period. Wood forms shall be kept sufficiently wet at all times to prevent the forms from separating at the joints and the concrete from drying.

Membrane Curing: Concrete surfaces to receive membrane curing shall be treated with a curing compound as specified or otherwise approved. The curing compound shall be applied in strict accordance with the directions of the manufacturer of the compound.

Temperature, Wind, and Humidity:

Cold Weather: When the mean daily outdoor temperature is less than 40 degrees F, the temperature of the concrete surface shall be maintained between 55 and 90 degrees F for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases that contain carbon dioxide. If early loading

is anticipated during cold weather, provide temperature protection to ensure necessary strength development.

The concrete surface temperature requirements (based on section thickness) in ACI 306.1 may be used in lieu of the 55 degrees F minimum specified before.

If concrete surface temperatures as measured by the inspecting agency are below the minimum curing temperature but meet the freeze protection requirements, the concrete curing period shall be extended to ensure adequate strength is developed. The extension time shall be at least equivalent to the time period in which temperatures were too low.

Hot Weather: The concrete surfaces shall be kept below 100 degrees F for the curing period. When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.

Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5 degrees F in any 1-hour or 50 degree F in any 24-hour period.

Use curing compound only where approved by Construction Manager. Cure formed surfaces with curing compound applied in accordance with manufacturer's directions as soon as forms are removed and finishing is completed.

WATER STOPS: PLASTIC AND HYDROPHILIC:

Install in accordance with manufacturer's instructions.

REPAIRING CONCRETE CRACKS:

Cracks requiring repair shall be determined by the Engineer and shall be repaired using epoxy injection. Method of epoxy injection shall be approved by the Construction Manager prior to application.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor Supplied Testing: The Construction General Contractor shall provide the necessary testing and monitoring services for the following:

Construction General Contractor shall procure the services of a qualified independent testing laboratory to control or monitor the production, transportation, placement, protection, curing, or temperature of the concrete as specified herein. Construction General Contractor shall submit qualifications of independent testing laboratory.

Evaluation of Concrete Field Strength:

Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.

Provide concrete for testing of slump, air content, and for making cylinders from the point of discharge into forms. When concrete is pumped, Samples used shall be taken from discharge end of pump hose.

Evaluation will be in accordance with ACI 301, Chapter 17, and Specifications.

Specimens shall be made, cured, and tested in accordance with ASTM C31 and ASTM C39.

Pumped Concrete: Take concrete samples for slump (ASTM C143) and test cylinders (ASTM C31 and C39).

Reject concrete represented by cylinders failing to meet strength and air content specified. For Class 30 concrete, reject concrete represented by cylinders failing to meet strength specified.

END OF SECTION 03301

DIVISION 4–MASONRY (NOT USED)

DIVISION 5–METALS

SECTION 05500 – METAL FABRICATIONS AND CASTINGS Sched. A & B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

THE ALUMINUM ASSOCIATION, INC. (AA)

The Aluminum Design Manual

AMERICAN GALVANIZERS ASSOCIATION (AGA)

Inspection of Products Hot-Dip Galvanized After Fabrication

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S329	Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Stainless Steel Types

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A10.11	Safety Requirements for Personnel and Debris Nets
ANSI A14.3	Ladders - Fixed - Safety Requirements
ANSI B1.1	Unified-inch Screw Threads (UN and UNR Thread Form)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.6	Structural Welding Code - Stainless Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	Specification for Carbon Structural Steel
ASTM A48	Specification for Gray Iron Castings
ASTM A53/A53M	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
ASTM A123/A123M	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153/A153M	Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A193/A193M	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A240/A240M	Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A278	Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degree
ASTM A283/A283M	Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile
ASTM A325	Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength
ASTM A380	Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A384	Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A489	Specification for Carbon Steel Lifting Eyes
ASTM A500	Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A563	Specification for Carbon and Alloy Steel Nuts
ASTM A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780	Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A793	Specification for Rolled Floor Plate, Stainless Steel
ASTM A967	Specification for Chemical Passivation Treatments for Stainless Steel Parts
ASTM A992/A992M	Specification for Steel for Structural Shapes for Use in Building Framing
ASTM B209	Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B308/B308M	Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B429	Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B632/B632M	Specification for Aluminum-Alloy Rolled Tread Plate
ASTM D1056	Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM F436	Specification for Hardened Steel Washers

ASTM F468	Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F593	Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	Specification for Stainless Steel Nuts
ASTM F844	Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F1554	Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

Evaluation Reports for Concrete and Masonry Anchors

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1910.27	Fixed Ladders
29 CFR 1926.105	Safety Nets
29 CFR 1926.502	Fall Protection Systems Criteria and Practices

SPECIALTY STEEL INDUSTRY OF NORTH AMERICA (SSINA)

Specifications for Stainless Steel
Design Guidelines for the Selection and Use of Stainless Steel
Stainless Steel Fabrication
Stainless Steel Fasteners

DEFINITIONS:

Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

Exterior Area: Location not protected from the weather by a building or other enclosed structure.

Interior Wet Area: Location inside building or structure where floor is sloped to a sump, floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Metal fabrications, including welding, shop and field weld WPSs, PQRs, and fastener information.

Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

Submit source quality control data specified herein.

Samples: Color samples of abrasive stair nosings.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Concrete and Masonry Drilled Anchors:

Manufacturer's product description and installation procedures.
ICBO evaluation report.
Adhesive Anchor Installer Certification.

Welding:

WPSs and WPQs.
CWI credentials and CWI reports.
Welding documentation.

U-Channel Concrete Inserts:

Manufacturer's product description.
Allowable load tables.

Ladders: Certification of load and fatigue tests.

Passivation method for stainless steel members.
Documentation of construction quality control inspections specified herein.

QUALIFICATIONS:

Adhesive Anchor Installers: Trained and certified by manufacturer.

Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

Welding: WPSs and WPQs in accordance with AWS D1.1.

DELIVERY, STORAGE, AND HANDLING:

Insofar as practical, factory assemble items specified herein. Assemblies that due to necessity have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

Package stainless steel items in a manner to provide protection from carbon impregnation.

Protect painted coatings and hot-dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

Store fabricated items in dry area, not in direct contact with ground.

PART 2 – PRODUCTS

GENERAL:

Unless otherwise indicated, meet the following requirements:

Item	**ASTM Reference**
Steel Shapes and Plates	A36/A36M or A992
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Structural Steel Tubing	A500, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316
Shapes	A276, AISI Type 304
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 55, with weldability supplement S1
Eyebolts	A489
Threaded Rods	A36/A36M
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48, Class 35

Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in FASTENER SCHEDULE at end of this section.

ANCHOR BOLTS AND ANCHOR BOLT SLEEVES:

Cast-In-Place Anchor Bolts:

Headed type, unless otherwise shown on Drawings.
Material type and protective coating as shown in FASTENER SCHEDULE at end of this section.

Anchor Bolt Sleeves:

Plastic:

Single unit construction with corrugated sleeve.
Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.

Material: High density polyethylene.

Manufacturer: Sinco Products, Inc., Middletown, CT. (800-243-6753).

Fabricated Steel: ASTM A36/A36M.

CONCRETE DRILLED ANCHORS:

GENERAL:

AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in FASTENER SCHEDULE at end of this section.

Current evaluation and acceptance reports by ICBO.

Wedge Anchors:

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Trubolt Wedge Anchor.
Hilti, Inc., Tulsa, OK; Kwik-Bolt II Stud Anchor.
Powers Rawl, New Rochelle, NY; Power-Stud Anchor.
Simpson Strong-Tie Co., Inc., Pleasanton, CA; Wedge-All Anchor.
Wej-It Corp., Tulsa, OK; ANKRtite Wedge Anchor.
U.S. Anchor, Pompano Beach, FL; Kingpin Wedge Anchor.

Expansion Anchors:

Self-drilling anchors, snap-off or flush type, zinc-plated.

Nondrilling Anchors: Flush type for use with zinc-plated or stainless steel bolt, or stud type with projecting threaded stud.

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Multi-Set II Drop-In and Self Drill Anchor.
Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.
Powers Rawl, New Rochelle, NY; Steel Drop-In Anchor.
Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.

Sleeve Anchors:

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Dynabolt Hex Nut Sleeve Anchor.
Powers Rawl, New Rochelle, NY; Hex Head Power-Bolt Anchor.
Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.
Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.

Adhesive Anchors:

Threaded Rod:

ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
Length as required, to provide minimum depth of embedment.
Clean and free of grease, oil, or other deleterious material.

Adhesive:

Two-component, designed to be used in adverse freeze/thaw environments, with gray color after mixing.

Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.

Nonsag, with selected viscosity base on installation temperature and overhead application where applicable.

Packaging and Storage:

Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.

Store adhesive cartridges on pallets or shelving in covered storage area, in accordance with manufacturer's written instructions.

Cartridge Markings: Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.

Dispose of cartridges if shelf life has expired.

Manufacturers and Products:

ITW Ramset/Red Head, Wood Dale, IL; Epcon Ceramic 6 Epoxy or A7 Adhesive Anchor System.

Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT HY 150 (HIT HY 20 for hollow masonry).

Powers Rawl, New Rochelle, NY; Power Fast Epoxy Injection Gel Cartridge System.

Simpson Strong-Tie Co., Inc., Pleasanton, CA; Epoxy-Tie Adhesive ET or Acrylic-Tie Adhesive. (Use only Acrylic-Tie Adhesive for temperatures below 40 degrees F.)

Covert Operations, Inc., Long Beach, CA; CIA-Gel 7000 Epoxy Anchors.

U.S. Anchor, Pompano Beach, FL; Ultrabond 1.

Unitex, Kansas City, MO; Pro-Poxy 300 and Pro-Poxy 300 Fast Epoxy Adhesive Anchors.

Diversified Fastening Systems of America, Charles City, Iowa; DFS Wedge Anchors.

Adhesive Threaded Inserts:

Stainless steel, internally threaded insert.

Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-R Insert with HIT HY 150 adhesive.

WELDED ANCHOR STUDS:

Headed anchor studs (HAS) or threaded anchor studs (TAS), as indicated on Drawings.

Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.

Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

Manufacturers:

Nelson Stud Welding, FabriSteel Co., Elyria, OH.
Stud Welding Associates, Inc., Elyria, OH.

EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING:

Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

Welded anchors for stainless steel support frames shall also be stainless steel.

ABRASIVE NOSING FOR STAIRS

Unless otherwise shown on Drawings, furnish flush type abrasive nosing on stairs.

Nosing Components:

Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.

Epoxy abrasive shall extend over and form curved front edge of nosing.

Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

Size: 3 inches wide by 1/4 to 3/8 inch thick by length as shown.

Color: Selected by Tank Farm Contractor from manufacturer's standard color range.

Manufacturers and Products:

Wooster Products, Inc., Wooster, OH; Spectra Type WP3C.
American Safety Tread Co., Inc., Helena, AL; Type FA-311D.

FABRICATION:

General:

Fabricate as shown and in accordance with AISC Specification for Structural Steel Buildings and AISC Code of Standard Practice for Steel Buildings and Bridges.

Finish exposed surfaces smooth, sharp, and to well-defined lines.

Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.

Fit and assemble in largest practical sections for delivery to site.

Materials:

Use steel shapes, unless otherwise noted.

Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.

Welding:

Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.

Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.

Steel: Meet fabrication requirements of AWS D1.1, Section 5.

Stainless Steel: Meet requirements of AWS D1.6.

Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1, Section 7, and manufacturer's instructions.

Complete welding before applying finish.

Painting:

Coat all fabricated carbon steel as specified in Section 09900, PAINT COATING SYSTEMS, unless otherwise indicated.

Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs and stainless steel anchor bolts, unless indicated otherwise.

Galvanizing:

Fabricate steel to be galvanized in accordance with ASTM A143, ASTM A384, and ASTM A385. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.

Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385.

Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.

Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.

Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.

Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.

Galvanized steel sheets in accordance with ASTM A653.

Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

SOURCE QUALITY CONTROL:

Visually inspect all fabrication welds and correct any deficiencies.

Steel: AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.

Stainless Steel: AWS D1.6.

Welded Anchor Studs: AWS D1.1 or AWS D1.6 as applicable.

PART 3 – EXECUTION

INSTALLATION OF METAL FABRICATIONS:

GENERAL:

Install metal fabrications plumb or level, accurately fitted, free from distortion or defects.

Install rigid, substantial, and neat in appearance.

Install manufactured products in accordance with manufacturer's recommendations.

Obtain Construction Manager approval prior to field cutting steel members or making adjustments not scheduled.

CAST-IN-PLACE ANCHOR BOLTS:

Accurately locate and hold anchor bolts in place with templates at the time concrete is placed.

Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

CONCRETE AND MASONRY DRILLED ANCHORS:

Begin installation only after concrete or masonry to receive anchors has attained design strength.

Install in accordance with manufacturer's instructions.

Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Min. Embedment (bolt diameters)	Min. Edge Distance (bolt diameters)	Min. Spacing (bolt diameters)
Wedge	9	6	12
Expansion and Sleeve	4	6	12
Adhesive	9	9	13.5

Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air.

When embedded steel or rebar is encountered in the drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Construction Manager for direction on how to proceed.

Adhesive Anchors:

Do not install adhesive anchors when temperature of concrete is below 40 degrees F (25 degrees F for Simpson Strong-Tie Acrylic-Tie Adhesive) or above 100 degrees F.

Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry where required by manufacturer's instructions.

Do not disturb anchor during recommended curing time.

Do not exceed maximum torque as specified in manufacturer's instructions.

ELECTROLYTIC PROTECTION:

Aluminum and Galvanized Steel:

Coat surfaces of galvanized steel fabricated and aluminum items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, PAINT COATING SYSTEMS, unless indicated otherwise.

Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

Allow coating to dry before installation of the material.

Protect coated surfaces during installation.

Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

Stainless Steel:

During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.

After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.

Remove contamination in accordance with requirements of ASTM A380 and A967.

Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.

After treatment, visually inspect surfaces for compliance.

REPAIR OF GALVANIZED STEEL:

Conform to ASTM A780.
For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780.
For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780.
Use magnetic gauge to determine that thickness is equal to or greater than the base galvanized coating.

FASTENER SCHEDULE:

Provide fasteners as follows:

Service Use and Location	Product	Remarks
Anchor Bolts Cast Into Concrete for Structural Steel Column Base Plates		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Anchor Bolts Cast Into Concrete for Metal Fabrications and Structural Components		
Interior Dry Areas	Stainless steel headed anchor bolts	
Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Zinc-plated or stainless steel wedge or expansion anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members
Connections for Steel Fabrications		
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections	
All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

Antiseizing Lubricant: Use on all stainless steel threads.

Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall inspect concrete drill anchor installation to verify compliance with anchor size, embedment, edge length, and spacing as specified herein and shown on the Drawings. Provide inspection documentation to Construction Manager.

END OF SECTION 05500

DIVISION 6–WOODS AND PLASTIC (NOT USED)

DIVISION 7–THERMAL AND MOISTURE PROTECTION

SECTION 07210-BUILDING INSULATION Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM C578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
ASTM C665	Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
ASTM D4397	Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data: Submit product data indicating compliance with the requirements of this section.

MATERIAL STORAGE:

Store off ground and keep dry at all times. Protect against weather condensation and damage.

PART 2 – PRODUCTS

MATERIALS:

Mineral/Glass Fiber Blanket/Batt Insulation: ASTM C665, Type III, Class B, fiberglass batts with vinyl vapor retarder; R-30 for roof and R-19 for walls.

Rigid Insulation: ASTM C578, Type IV, extruded polystyrene; R-value as shown.

Vapor Retarder: ASTM D4397 plastic sheeting, 6 mils minimum.

PART 3 – EXECUTION

INSTALLATION:

Batt Insulation:

Install in accordance with the manufacturer's instructions.

Fasten flanges to the sides of framing members with the vapor retarder facing the warm side. Fit tightly to ensure a continuous seal.

Where electrical outlets, ducts, pipes, vents, or other utility items occur, place insulation on the cold weather side of the obstruction.

Provide fasteners, adhesive, tape, and sealant as recommended by insulation manufacturer.

Vapor Retarder:

Apply to inside face of exterior wall and ceiling framing in sheets as large as possible, lapping all joints 6 inches and sealing with sealant and tape recommended by manufacturer.

Fit tightly and seal around all penetrations.

Replace torn and punctured sheets.

Repair minor tears or holes with tape.

Repair by replacement major tears or holes that require more than a 6-inch length of tape to repair.

Rigid Insulation:

Install with fasteners or adhesive recommended by manufacturer.

Butt joints tightly together.

Where thicker than 2 inches, install in two layers, staggering all joints.

CLEANUP AND PROTECTION:

Remove from site all containers, wrappings, and scrap insulation material. Leave floors broom clean.

Protect installed insulation from tears or other damage until covered with finish material. Replace damaged material.

END OF SECTION 07210

DIVISION 8–DOORS AND WINDOWS (NOT USED)

DIVISION 9–FINISHES

SECTION 09900—PAINT COATING SYSTEMS Sched. A & B

PART 1 – GENERAL

REFERENCES:
The following documents and others referenced therein form part of Contract to the extent designated. Referenced documents are those current, unless otherwise indicated.

ASTM INTERNATIONAL (ASTM)

ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D570	Test Method for Water Absorption of Plastics
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D714	Test Method for Evaluating Degree of Blistering of Paints
ASTM D772	Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
ASTM D1653	Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D3912	Test Method for Chemical Resistance of Coatings Used in Light-Water Nuclear Power Plants
ASTM D4060	Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4082	Test Method for Effects of Gamma Radiation on Coatings for Use in Light-Water Nuclear Power Plants
ASTM D4259	Standard Practice for Abrading Concrete
ASTM D4263	Test Method for Indicating Moisture Content in Concrete by the Plastic Sheet Method
ASTM D4541	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5139	Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants
ASTM D5144	Guide for Use of Protective Coating Standards in Nuclear Power Plants
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP 3	Power Tool Cleaning
SSPC-SP 6	Commercial Blast Cleaning

SUBMITTALS–approval required:

See Section 01300, SUBMITTALS, for submittal procedures

List of Materials: Before delivery, submit colors and location to be used and manufacturer catalog data sheets and charts showing adequate information to substantiate compliance to the requirements of this section. Submittal shall also enumerate percentage of volatile and nonvolatile materials, percentage of component parts of each type of material, and the conversion factors to determine dry film thickness from

applied wet film thickness. Also, submit Material Safety Data Sheets (MSDS) for materials proposed to be used.

Installer's Certificate (Decontaminable Coatings Only): Before application, submit documentation that the application crew has been certified by the coating system manufacturer as qualified to apply the selected coating system. As an alternative to crew certification, a submittal documenting onsite training by a technical representative from the coating manufacturer would be acceptable.

Cleaning and Disposal Plan: Before application, submit a plan for proper collection, storage, and disposal of all materials spotted or soaked with paint, oil, solvents, and other flammable waste materials. The plan shall also address handling and disposal of empty cans. The plan shall address both daily cleanup requirements and cleanup at the completion of the coatings application activities.

Submit documentation and test results from construction quality control testing specified herein.

DELIVERY, STORAGE, AND HANDLING:

Obtain inspection and acceptance by Tank Farm Contractor before opening containers or removing labels.

PROJECT CONDITIONS:

Environment for Coating: Coat exterior surfaces only when ambient and surface temperatures are within the range recommended by the coating manufacturer for the respective coating, which is within 40 to 120 degrees F, and ambient temperature is a minimum of 5 degrees F above the dewpoint.

PART 2 – PRODUCTS

MATERIALS:

Shop Primer for Carbon Steel Assemblies: Ameron-Amerlock 400.

Decontaminable Coatings for all Metal and Concrete: (Service Level II as defined in ASTM D5144)

Decontaminability: Evaluation of coating systems decontaminability as noted in ASTM D5144 Section 5.4, is difficult to quantify. To determine the coating systems decontamination properties, the coating system shall be tested for chemical resistance properties as addressed in this specification.

Radiation Tolerance: Coatings applied to the specified thickness shall demonstrate tolerance to a total accumulated dose in air of 6×10^7 Rads of gamma radiation in accordance with ASTM D4082. Test samples shall be prepared in accordance with ASTM D5139.

Physical Properties: Base and finish coatings shall have the physical property strengths shown in the tables below as determined by the respective test method.

For Rigid Decontaminable Coatings (High Solids Epoxies):

Test	Method	Results
Adhesion to Substrate	ASTM D4541	Steel-Minimum 900 psi Concrete-8% of concrete compressive strength
Elongation at break at 75°F		Minimum 5%
Water Absorption or	ASTM D570 (24 hr)	Maximum 0.5%
Moisture Vapor Transmission	ASTM D1653	Maximum 8 gm/m^2
Wear Resistance (Finish or lost Top Coat Only)	ASTM D4060, 1,000 cycles, 1,000 g weight, CS-17 wheel	Less than 175 mg

Chemical Resistance: The coating system shall be resistant to the standard decontamination solutions listed in ASTM D3912, Figure 1. Chemical resistance testing shall be in accordance with ASTM D3912, or an equivalent standard, for occasional splash and spillage service, except test samples shall be prepared in accordance with ASTM D5139. Submit manufacturer's chemical resistance test plan, including procedure for exposing coating samples for evaluating occasional splash and spillage conditions, for evaluation and approval. Criteria for acceptance shall be based on the following:

Flaking: As evaluated in accordance with ASTM D772, flaking and peeling shall not be permitted

Blistering: As evaluated in accordance with ASTM D714, blisters shall be limited to size 4, 6, or 8, and a frequency no more than a "few."

Delamination will not be permitted.

Slight discoloration will be permitted.

Coating shall be volatile organic content (VOC) compliant with a maximum VOC of 2.9 lbs/gal.

Fire Characteristics: Coatings used shall not develop significant qualities of toxic or other harmful products of combustion when exposed to fire. Coatings shall have a UL (ASTM E84/NFPA 255*)* flame spread rating of 25 or less and smoke developed rating of 50 or less.

Coatings shall be repairable for cracks appearing through the applied-coated surface to the substrate and for chips and flaking due to mechanical damage.

Coating shall have a design life of 12 years. In addition to radiation tolerance requirements, coating shall be resistant to humidity ranging from 0 to 100 percent and an ambient air temperature range of 120 degrees F to minus 32 degrees F, with a maximum 24-hour differential of 52 degrees F.

Primers, thinners, and coating accessory materials shall be produced or approved for use by the same manufacturer as the finish coating system.

Decontaminable Coating Systems (Epoxies), or Approved Substitute:

Manufacturer Product	Ameron
Steel and Concrete Primer	Amerlock 400
Concrete Surfacer	Nu-Klad 114A
Base Coating	Amerlock 400
Intermediate and Finish Coating	PSX 700 Siloxane

Joint Sealant: "Nu-Klad 750A/760A" by Ameron, or approved substitutes, shall be used.

Scrim Cloth: Glass fiber reinforcing fabric as recommended by coating system manufacturer.

PART 3 – EXECUTION

EXAMINATION:

Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, performance, or quality of work, and that cannot be put into acceptable condition through preparatory work.

Report conditions that could adversely affect proper application of coatings, in writing, to Construction Manager. Do not begin surface preparation or coating application until defects have been corrected and conditions have been made suitable.

PREPARATION:

Before application, remove as much dust and debris as possible from space or area to receive coating to allow for proper installation.

Pre-Priming:

Ferrous Metal and Carbon Steel:

Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

Prepare shop assemblies in accordance with SSPC-SP 6. Remove abrasive residue and dust, and prime within 4 hours after preparation. Apply minimum of 3.0 mil of shop primer in accordance with manufacturer's recommendations.

Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.

Prepare field erections in accordance with SSPC-SP 3 or SSPC-SP 6. Remove abrasive residue and dust.

Surface Preparation: Shop and field surface cleaning and surface preparation requirements for all substrates shall be in accordance with the manufacturer's written instructions and these Specifications. Where the specified degree of surface preparation differs from the manufacturer's recommendations, the more stringent shall apply.

Concrete shall be at least 30 days old before coating is applied.

Prior to application of coating system or surfacer to new concrete surfaces, perform a plastic sheet test in accordance with ASTM D4263. The test shall be initiated in the afternoon and completed the following morning. The absence of condensation on the test sheet shall indicate the concrete is ready to have the coating system applied. Document test results.

Clean new concrete surfaces to be coated by Abrasive Blast Cleaning Procedures in accordance with ASTM D4259.

Prepare or repair construction joints, shrinkage cracks, and other non-expanding cracks, gaps, or crevices in the surface to be coated, in accordance with coating manufacturer's recommendations. Scratches, cracks, holes, pinholes, and abrasions shall be cut back to proper key and filled with surfacer.

Post-Priming:

Feather abrasions, chips, skips, and holidays occurring in prime coat by sanding, and recoat with material and color to minimum dry film thickness specified.

Previously coated surfaces shall be recoated only after existing film is completely dry. Some coating systems require the application of succeeding coats within a set time frame for it to properly adhere to the previous coat. Should the time frame recommended by the coating manufacturer be exceeded, prepare the base coat as recommended by the coating manufacturer.

Protection:

Provide and install drop cloths, shields, and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings, and over-run of coating materials to a minimum and remove as coating work progresses.

Protect coating from rain until dry to touch.

Upon completion of each coating application, protect coated surfaces from physical damage or chemical contamination.

APPLICATION:

Apply coating materials in accordance with manufacturer's recommendations.

Apply with equipment recommended by coating manufacturer.

Number of Coats, Film Thickness:

Apply the minimum number of coats specified without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

Maximum film build per coat shall not exceed coating manufacturer's recommendations.

Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thickness is likely to be present, and ensure proper millage in these areas.

Sealant Application:

Rigid Coating Systems: After pre-primer is installed (see Article COAT SCHEDULE), apply sealant to expansion joints at the coated surface boundary. Mask limits of joint to provide a neat appearance. Roughen contact surfaces with sandpaper. Prime and install sealant in accordance with manufacturer's instructions.

Identify each coat of opaque material by its relation to color of finish coat. Prime coat shall be darkest tint of specified color with each succeeding coat lighter, up to finish coat, which shall be color, tint, and sheen specified in Article COAT SCHEDULE or as shown on the Drawings. Tints of identical coats of identical color and material shall not vary.

Recoat and repair as necessary for compliance with the Specifications.

CLEANING:

Collect and dispose of materials spotted or soaked with paint, oil, or solvents, and other flammable waste materials daily in accordance with the coating manufacturer's recommendations. Minimize volume of potentially contaminated solids and liquids that must be disposed.

Salvageable brushes, rollers, spatulas, and spray equipment shall be thoroughly cleaned after use and shall contain no oils, thinners, or other residue after cleaning.

Dispose of empty cans at end of each shift in accordance with the cleaning and disposal plan.

At completion of coating work, remove and dispose of materials, containers, rags, cloths, brushes, equipment, and miscellaneous other debris in accordance with the cleaning and disposal plan. Clean up spills and report, if required, in accordance with the cleaning and disposal plan.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform the field tests specified herein with properly calibrated instruments. All testing shall be performed and recorded by personnel trained in the use of the test instruments.

Thickness Testing:

Measure coating thickness on steel with a properly calibrated, magnetic type dry film thickness gauge (as manufactured by Nordson; or approved equal).

Measure the wet film thickness (WFT) of each coat of material with a notched WFT gage (Nordson 790-015) at a minimum of five evenly spaced points for each 100 square feet of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness.

Adhesion Testing:

Adhesion testing is required where the specified decontaminable coatings system is applied to concrete.

Perform adhesion testing at each field or shop location where surfaces are prepared and coatings are applied.

After surface preparation and coating application procedures have been observed and approved by the paint manufacturer's representative, select one representative location for an adhesion pull test. If the adhesion pull test does not meet the specified requirement, perform additional pull tests to determine the area of inadequate adhesion. Remove and replace coatings with inadequate adhesion.

If changes are observed in the shop or field application procedures that may affect coating adhesion, Construction Manager may require additional adhesion tests.

Construction General Contractor shall provide all test equipment required for adhesion testing.

Repair all coatings damaged by adhesion testing in accordance with the coating manufacturer's directions.

Inspection: Perform tests to ascertain that coating materials have been applied as specified in this section. Document test results. Document surface preparation, application of all coats of material, and performance of wet and dry film thickness testing in accordance with this section.

Perform water tightness test of concrete sumps in accordance with Component Construction Acceptance Test as provided in the Construction Inspection Plan, RPP-18490, Rev. 0.

APPLICATION SCHEDULE:

Concrete: Coat exposed concrete surfaces of building slabs, truck loading slab, sump, and other concrete surfaces as shown on the Drawings.

Carbon Steel:

Coat all exposed carbon steel with the coating system specified in Article COATING SCHEDULE.

Coat concrete embedded anchor bolts and concrete embedded structural steel with carbon steel coating system, except delete intermediate and finish coats. Repair coating on anchor bolt threads after nuts are installed in accordance with manufacturer's recommendations.

See Section 13122, METAL BUILDING SYSTEMS, for painting requirements associated with prefabricated steel buildings and Section 13205, LINED BOLTED STEEL LIQUID STORAGE TANKS, for painting requirements associated with the bolted steel tank.

Aluminum and Galvanized Steel in Contact with Concrete: Coat aluminum and galvanized steel in contact with concrete with carbon steel coating system, primer only. Provide a minimum dry film thickness of 4 mils.

COAT SCHEDULE:

Coat	Description	Color (*see Note 1)	Minimum Dry Film µm (mils)
Concrete – Rigid Coating System (Epoxies):			
Pre-Prime	Amerlock 400-thinned approx. 20-25% with #65 thinner.	N/A	Enough to seal surface
Joint Sealer	NuKlad 760A	N/A	N/A
Surfacer	NuKlad 114A	N/A	As required to fill voids
Prime and Base	Amerlock 400	*	Two coats: Prime 75 (3.0) Base 100 (4.0)
	PSX 700 Siloxane	*	
Intermediate and Finish. Between coats wipe entire surface with clean thinner #65, #12, or equal.			Two coats: Intermediate 100 (4.0) Finish 100 (4.0) (See Note 2)
Vitrogrit crushed glass abrasive	#29 Round Mesh (See Note 7)		
Carbon Steel:			
Shop and Field Primer	Amerlock 400, see Note 3	*	75 (3.0)
Base	Amerlock 400, see Note 3	*	100 (4.0)
Intermediate	See Note 4 PSX 700 Siloxane	*	100 (4.0)
Finish	PSX 700 Siloxane		100 (4.0)
PVC (exterior UV exposed):			
Finish	Carbocrylic 3359 DTM (See notes 5 and 6)		100 (4.0)

Notes:

1. Contrast each coat from primer-darker to finish-lighter. Finish coat to be off-white to white, except bollards, truck loading connection piping support, and manhole lids, which shall be yellow.
2. Verify recoating times between intermediate and finish coats with the coating manufacturer if relative humidity is less than 40 percent.
3. Prime and base coats may be applied in single 180 µm coat if base coat is self-priming.
4. For anchor bolts, delete intermediate and finish coats.
5. Prepare PVC by hand tool cleaning (scuff sand) using minimum 80 grit sandpaper in all directions.
6. For PVC associated with stilling wells at leachate tanks, coat only PVC exposed to UV above tank floating cover.

7. For the Truck Loading concrete pad, apply #29 round mesh VitroGrit crushed glass abrasive in between the intermediate and final coat in accordance with manufacturer's recommendation. After the intermediate coat is applied spread the sand in excess over the wet surface and let dry. After the surface has dried, sweep or vacuum the excess sand and apply the final coat.

END OF SECTION 09900

DIVISION 10–SPECIALTIES (NOT USED)

DIVISION 11–EQUIPMENT

SECTION 11305-COMBINED AND BUILDING SUMP PUMPS Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards that may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI).

ASTM INTERNATIONAL (ASTM)

ASTM A48 Standard Specification for Gray Iron Castings

ASTM A576 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality

HYDRAULIC INSTITUTE STANDARDS (HIS)

NATIONAL ELECTRIC CODE (NEC)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electric Code

UNDERWRITERS LABORATORIES INC. (UL)

DEFINITIONS:

Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.

Power and control wiring diagrams, including terminals and numbers.
Complete motor nameplate data, as defined by NEMA, from motor manufacturer.
Functional testing plan demonstrating compliance with requirements specified herein.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Results of construction quality control testing.

Vendor Information (VI):

Manufacturer's printed installation instructions, operations, and maintenance data, including preventative maintenance tasks and frequencies for performance of those tasks.

Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

Factory finish system.

EXTRA MATERIALS:

Furnish for each pump: One set mechanical seals.

PART 2 – PRODUCTS

SUPPLEMENTS:

Specific requirements are attached to this section as supplements.

COMPONENTS:

Pump equipment shall consist of pump(s) complete with motor(s), anchoring brackets, power cable(s), and pump lifting cable(s).

Lifting Arrangement: 2 feet minimum, stainless steel chain, and one "grip-eye". Attach chain permanently to pump and access platform with stainless steel wire rope. "Grip-eye" will be capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with "grip-eye" and independent hoist.

Components – Typical:

Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti-leak seal and shall be easily accessible from outside.

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cable shall be of sufficient length to reach junction boxes without strain or splicing.

Cable Entry System:

Junction chamber and motor shall be separated by stator lead sealing gland or terminal board that shall prevent foreign material entering through pump top.

Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.

O-ring compression seal between sealing gland and cable entry point shall also be acceptable.

ACCESSORIES:

Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in readily visible location.

Lifting Lugs: Equipment weighing over 100 pounds.

FACTORY FINISHING:

Manufacturer's standard enamel finish.

PART 3 – EXECUTION

INSTALLATION:

Install in accordance with manufacturer's printed instructions.
Connect suction and discharge piping without imposing strain to pump flanges.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall perform functional testing in accordance with approved test plan. Functional testing shall be performed in presence of Construction Manager or representative designated by the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Functional Test: Conduct on each pump.

Flow Output: Measured by plant instrumentation and/or storage volumes.
Amp Draw: Verify motor current agrees with motor nameplate.
Test for continuous 30-minute period.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION", are part of this Specification.

Sump Pump Data Sheet, 11305-01.
Sump Pump Data Sheet, 11305-02.

END OF SECTION 11305

Sump Pump Data Sheet, 11305-01

Tag Numbers: 219A-LH-P-207, 219E-LH-P-207

Pump Locations and I.D.: Buildings 219A and 219E, Combined Sump Pump

Manufacturer and Model Number: (1) Hydromatic Pump Co., Model SB3S
(2) Barnes
(3) Or approved equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste disposal facility and rain/snow melt

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5.0-9.3

Abrasive (Y/N) (fine/coarse soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) 0.5

PERFORMANCE REQUIREMENTS:

Capacity (US gpm): Rated: 250
Total Dynamic Head (Ft): Rated: 19
Maximum Shutoff Pressure (Ft): 50
Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 50
Max. Pump Speed at Rated Capacity (rpm): 1,750
Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Pump Type: Heavy-Duty Nonclog (Y/N) Y

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

INDUCTION DRIVE MOTOR:

Horsepower: 0.30 Voltage: 460 Phase: 3 Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N): N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Explosion-proof, submersible, Class 1, Div. 1 or Div. 2, Groups C and D

Sump Pump Data Sheet, 11305-02

Tag Numbers: 219A-LH-P-205, 219E-LH-P-205

Pump Locations and I.D.: Buildings 219A and 219E, Floor Sump

Manufacturer and Model Number: (1) Hydromatic Pump Co.

(2) Barnes

SERVICE CONDITIONS:

Liquid Pumped: Leachate from low-level radioactive waste disposal facility

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5-9.3

Abrasive (Y/N) Y (fine/coarse soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) 0.5

PERFORMANCE REQUIREMENTS:

Capacity (US gpm): Rated: 28

Total Dynamic Head (Ft): Rated: 14

Maximum Shutoff Pressure (Ft): 30

Min. Rated Pump Hydraulic Efficiency at Rated Capacity (%): 45

Max. Pump Speed at Rated Capacity (rpm): 1,750

Constant (Y/N): _____ (Y/N): _____

DESIGN AND MATERIALS:

Pump Type: Heavy-Duty Nonclog (Y/N) Y

Volute Material: Cast Iron ASTM A48

Pump Casing Material: Cast Iron ASTM A48

Motor Housing Material: Cast Iron ASTM A48

INDUCTION DRIVE MOTOR:

Horsepower: 0.30 Voltage: 460 Phase: 3 Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N): N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

SECTION 11306-LEACHATE PUMPS Sched. B

PART 1 – GENERAL

GENERAL:

Provide multi-stage, centrifugal, submersible pumps specifically designed for landfills and sideslope installations. Pumps shall be designed for pumping contaminated water and leachate. Provide all necessary pump appurtenances including lifting cable for lowering and removing the pump, power cable, a minimum 4-wheel system at each end of the pump specifically designed for transporting the pump in HDPE butt-fused carrier pipe, outlet pipe attachments and flex hose as necessary, and all other fittings or accessories required for a complete and fully functional installation.

The pump and all associated appurtenances shall be designed by the pump manufacturer to operate as a fully functional and reliable pump system. Provide a pump system capable of operating unattended with a high degree of reliability with multiple cycles per day.

Provide vent valve system, if necessary, to purge air from pumps to prevent pump air lock. Vacuum air release valves are provided in system piping at top of riser.

Provide quick-couple fitting at end of pump where outlet pipe attaches.

Remove pump discharge check valve or drill hole in check valve to prevent water from accumulating above pump outlet. Pump shall be fully capable of operating with check valve removed.

Provide stainless steel tag numbers and mounting fasteners and engrave with the equipment tag number and model number for each pump.

Note that pump control will be accomplished through software programming and the PLC mounted in the system control panels (by others) located in each Crest Pad Building.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Functional testing plan demonstrating compliance with requirements specified herein.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Detailed catalog information, descriptive literature, and specifications of all components associated with pump removal system.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Manufacturer's certification of factory testing to establish conformance with specified requirements. Certification must include certificates of calibration traceable to a nationally recognized standards organization such as National Institute of Standards and Technology (NIST).

Special shipping, storage and protection, and handling instructions.

Manufacturer's Certificate of Proper Installation.

Results of field quality control testing.

Vendor Information (VI):

Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Operation and maintenance manual.

PART 2 – PRODUCTS

PUMPS:

All major components shall be Type 304 stainless steel including the housing, fasteners, shaft, diffuser chamber, and impeller(s). Components shall be highly corrosion resistant and suitable for contaminated water and leachate service. Gaskets, O-rings, and seals shall have compatibility properties equivalent to Viton material as a minimum.

Pump bearings shall have better heat and wear resistance than Teflon bearings.

Provide power and stainless steel cable as recommended by manufacturer and to the length and configuration as shown on the Drawings.

MOTORS:

Provide sealed pump motors suitable for continuous submerged service. Provide continuous motor leads without splices along the full length of the discharge pipe. Leads shall be fully insulated with chemical and waterproof insulation properties. Provide motor designed for continuous duty and multiple cycle times of 60 starts per hour. Motors shall have thermal overload protection.

SOURCE QUALITY CONTROL:

Construction General Contractor shall perform source quality testing at the factory as specified herein. Notify Construction Manager in writing at least 10 days in advance of testing. Construction Manager will coordinate with personnel required to witness testing.

Factory Tests and Adjustments: Test all equipment actually furnished.

Factory Test Report: Include test data sheets, curve test results, performance test logs.

PERFORMANCE TEST:

Conduct on each pump.

Perform under simulated operating conditions, at a minimum of six operating points on the pump curve.

Test for a continuous 30-minute period without malfunction. Check for excessive or abnormal vibrations and correct deficiencies.

Test Log: Record the following:

Total head.

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Adjust or modify units and retest if necessary.

Pump Removal System:

Provide one common manual pump removal winch and winch support for raising and lowering the LCRS low flow and secondary leak detection pump and associated discharge piping. Provide one manual pump removal winch and winch support for raising and lowering the high flow pump and associated discharge piping. Winches shall be brake (spur gear) winch with automatic brake: Thern Model No. 4032PB (low flow/secondary leak detection) and M452B (high flow), or equal. Provide winch with sufficient capacity to handle required length of lifting cable (stainless steel wire rope). Lifting cable shall include and the winch accommodate a swage ball fitting cable end for quick connect/disconnect.

Winch shall be mounted on structural steel support. The winch support shall only be installed for pump installation/removal. Three sets of drop-in anchors shall be installed in floor that match the winch support base bolt pattern. Each set of drop-in anchors shall be located to align the winch support with each HDPE riser pipe such that the lifting cable does not rub the HDPE riser pipe during pump installation/removal. Coordinate location of the drop-in anchors with Construction Manager.

Provide two manual hose reels for separately handling the leachate pump power and level transducer cables. Hose reels shall be heavy-duty hand crank reels with adjustable spool rotation drag and spool lock pins. Hose reels shall be Reelcraft Model No. C33118LI, or equal. Each reel shall be located as required for proper alignment with appropriate riser pipe. Drop-in anchors shall be installed in floor that match hose reel “feet” bolt pattern for both reels. Bolts shall be left in place to prevent accumulation of dirt, etc., in anchor threads. Bolts shall be tapered flathead to eliminate tripping hazard.

LEVEL SENSORS:

Provide level sensors integral to Cell 1 and Cell 2 LDS leachate pump (two total) as shown on the Drawings. Level elements shall be designed and constructed for landfill leachate service, i.e., fully submersible and chemically resistant.

The level sensor shall include a transmitter with built-in temperature compensation and an accuracy of plus or minus 1.0 percent. Sensor output shall be a conditioned compensated 4 to 20 mA signal.

The sensor control cable shall be shielded to prevent signal disruption and include a vent tube for atmospheric pressure compensation. Control cables shall include polyurethane jacket and Kevlar tension members.

Level sensors shall be mounted on the pump housing and be field serviceable without having to disassemble the pump.

PART 3 – EXECUTION

INSTALLATION:

Install in accordance with manufacturers' printed instructions and manufacturers' representatives' guidance and recommendations.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall perform functional testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Function Tests:

Prior to the pump and level transducer insertion tests identified in the Component CAT procedures, verify the LCRS, LDS, and SLDS riser pipe transition from the side slope to the horizontal portion of the riser pipe is adequate for leachate pump and level transducer insertion. Perform the pump/level transducer insertion tests prior to backfilling and after the riser pipe installation is finished from within the sump to a location approximately 50 feet up the side slope. Perform the pump/level transducer insertion tests using the associated leachate pump or level transducer for each riser. In addition to the level transducer insertion for the SLDS riser pipe, test the transition using the LDS low-flow leachate pump as well. If actual level transducers or leachate pumps are not available at the time of the testing, "dummy" level transducers and pumps can be used per approval from CHG Construction Manager.

After complete installation of the side slope riser pipe from the sump to the crest pad building, verify exact length of pump discharge and level transducer piping required by using a long tape measure to measure actual dimension. Test the insertion and extraction of each pump from the side slope riser pipe and into the crest pad buildings. Perform testing while the perforated carrier pipe sections in the sumps are exposed to allow observation of the pump removals and insertions from the carrier pipe.

Test the pumps under simulated conditions using a temporary tank located at the bottom of the landfill. Place pump in the tank and connect temporary flexible hose between the pump and discharge pipe routed up the side slope surface and between the discharge pipe and riser connection in Crest Pad Building. Keep the tank full to supply adequate water to the pumps during the pump test. Record amp draw readings.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Data Sheets:
Supplement 1—Leachate Pump Data Sheet, 11306-01.
Supplement 2—Leachate Pump Data Sheet, 11306-02.
Supplement 3—Leachate Pump Data Sheet, 11306-03.
Supplement 4—Leachate Pump Data Sheet, 11306-04

END OF SECTION 11306

Leachate Pump Data Sheet, 11306-01:

Tag Numbers: 219A-LH-P-202, 219E-LH-P-202

Pump Locations and I.D.: Cell 1 LCRS Sump, Low Flow
Cell 2 LCRS Sump, Low Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 3-3
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 13

Total Dynamic Head (Ft): Rated: 66

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 90

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 0.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-02:

Tag Numbers: 219A-LH-P-203, 219E-LH-P-203

Pump Location and I.D.: Cell 1 LCRS Sump, High Flow
Cell 2 LCRS Sump, High Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 30-4
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 155

Total Dynamic Head (Ft): Rated: 118

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 208

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic), or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide (engineered plastic), or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 7.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-03:

Tag Numbers: 219A-LH-P-204, 219E-LH-P-204

Pump Locations and I.D.: Cell 1 LDS Sump
Cell 2 LDS Sump

Manufacturer and Model Number: (1) EPG Companies; Model WSD 1.5-3
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 4

Total Dynamic Head (Ft): Rated: 65

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 80

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 0.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Leachate Pump Data Sheet, 11306-04:

Tag Numbers: 219-LH-P-208

Pump Locations and I.D.: Cell 1 SLDS Sump
Cell 2 SLDS Sump

Manufacturer and Model Number: (1) EPG Companies; Model WSD 1.5-4
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5.0-9.3

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 4

Total Dynamic Head (Ft): Rated: 65

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 80

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 0.5 Voltage: 120 Phase: 1

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

Note: An adequate length of power cord shall be supplied. Standard plug shall be provided on the power cord.

SECTION 11312-HORIZONTAL END SUCTION CENTRIFUGAL PUMPS Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN BEARING MANUFACTURERS' ASSOCIATION (ABMA)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Type 416	Stainless Steel
Type 1035	Steel
Type 1045	Carbon Steel
Type 4140	Alloy Steel

ASTM INTERNATIONAL (ASTM)

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE STANDARDS

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	Motors and Generators

DEFINITIONS:

Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head,

capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Functional testing plan demonstrating compliance with requirements specified herein.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Special shipping, storage and protection, and handling instructions.
Manufacturer's Certificate of Proper Installation.
Results of field quality control testing.

Vendor Information (VI):

Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions.

Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Factory finish system data sheets.

EXTRA MATERIALS:

Furnish for each pump:
Complete set packing.
Complete set bearings.
Complete set gaskets and O-ring seals.
Complete set of shaft sleeves.
Complete set keys, dowels, pins, etc.
Complete mechanical seal.

Impeller.
Impeller shaft.
Impeller wear ring.
Head shaft.
One complete set of any special tools required to dismantle pump.

PART 2 – PRODUCTS

GENERAL:

Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

SUPPLEMENTS:

Some specific requirements are attached to this section as supplements.

ACCESSORIES:

Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

Lifting Lugs: Equipment weighing over 100 pounds.

Anchor Bolts: Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

FACTORY FINISHING:

Manufacturer's standard enamel finish.

SOURCE QUALITY CONTROL:

Construction General Contractor shall perform source quality control testing at the factory as specified herein. Notify Construction Manager at least 10 days in advance of testing.

Performance Test: Perform manufacturer's standard motor test on equipment.

PART 3 – EXECUTION

INSTALLATION:

Install in accordance with manufacturer's printed instructions.

Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout. Remove wedges after grout is set and pack void with grout.

Connect suction and discharge piping without imposing strain to pump flanges.

Anchor Bolts: Accurately place using equipment templates and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall perform field quality control testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Functional Tests:

Conduct on each pump.

Test for a continuous 1/2-hour period without malfunction.

Test Log: Record the following:

Total head.

Capacity.

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

MANUFACTURER'S SERVICES:

Manufacturer's Representative: Present at site or classroom designated by Tank Farm Contractor, for minimum person-days listed below, travel time excluded:

1 person-day for installation assistance and inspection.

1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Pump Data Sheet, 11312-01

END OF SECTION 11312

Horizontal End Suction Centrifugal Pump Data Sheet, 11312-01:

Tag Numbers: _____

Pump Name: _____

Manufacturer and Model Number: (1) _____

(2) _____

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): _____

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: N/A pH: 5.0-9.3

Abrasive (Y/N) Y (fine soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) .25

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 250

Total Dynamic Head (Ft): Rated: 25

Min. Hydraulic Efficiency (%): 75

Maximum Shutoff Pressure (Ft): 40

Max. Pump Speed at Design Point (rpm): 1,750

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

ANSI (Y/N) Y Standard (Y/N) Y Design: Frame-mounted (Y/N) Y

Close-Coupled Casing (Y/N) N Back Pullout (Y/N) Y

Discharge Orientation: 12:00 Rotation (view from end coupling): CW

Shaft Seal: Packing (Y/N) N

Mechanical (Y/N) _____

Lubrication: Process Water

Drive Type: Direct-Coupled: _____ Belt _____ Adjustable Speed _____

INDUCTION DRIVE MOTOR:

Horsepower: _____ Voltage: _____ Phase: _____ Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N) _____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Totally enclosed fan cooled

Mounting Type: Horizontal _____ Nonreverse Ratchet (Y/N) _____

TESTING:

Pump Tests: Factory Functional (Y/N) _____ Field Performance (Y/N) N

Factory Hydrostatic Casing Pressure Test (Y/N) _____

Field Functional (Y/N) _____ Field Performance (Y/N) _____

Field Vibration (Y/N) N

DIVISION 12–FURNISHINGS (NOT USED)

DIVISION 13–SPECIAL CONSTRUCTION

SECTION 13122-METAL BUILDING SYSTEMS Sched. B

PART 1 – GENERAL

WORK INCLUDED:

The Construction Subcontractor shall furnish and install four prefabricated pre-engineered metal building, complete, as shown on the Drawings and as specified herein.

REFERENCES:

The following Codes and Standards, including others referenced therein, form a part of this Section to the extent specified herein:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC	Specification for Structural Steel for Buildings – Allowable Stress Design (ASD)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI	Specification for the Design of Cold-Formed Steel Structural Members

ASTM INTERNATIONAL (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A570	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A572	Standard Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel
ASTM A607	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled, and Cold-Rolled
ASTM F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 Structural Welding Code – Steel

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

Recommended Design Practices Manual, for applicable loads and load combinations

Metal Building Systems Manual, for collateral loads

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

UBC, Uniform Building Code

STEEL DOOR INSTITUTE (SDI)

SDI 100 Recommended Specifications for Standard Steel Doors and Frames

SDI 117 Manufacturing Tolerances Standard Steel Doors and Frames

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Manufacturer's Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.

Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed metal building system.

Painting System: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats. Provide minimum 20 color samples for Tank Farm Contractor to choose.

Drawings Stamped by Engineer Registered in the State of Washington and Prepared Specifically for this Project:

Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.

Calculations Stamped by Engineer Registered in the State of Washington: Complete structural stress and deflection analysis of structural components and connections; consider prying action of bolts should proposed design use bolted moment-resistant connections in main frames. Provide anchor bolt calculations and separately tabulate anchor bolt reaction for all case loads and load combinations.

Samples: Minimum 2-inch by 3-inch metal for components requiring color selection.

Submit documentation of construction quality control testing as specified herein.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Statements of Qualification:

Documentation of past 5 years' experience record to include project name, location, type and date completed, building manufacturer and owner's contact person.

Certification of approval by manufacturer.

Vendor Information (VI):

Manufacturer's written instructions for shipping, handling, storage, protection and erection or installation of building and components.

Manufacturer's certification or proof of current membership in Metal Building Manufacturer's Association (MBMA).

Manufacturer's Certificate of Proper Installation.

Operations and maintenance manual.

QUALIFICATIONS:

Provide prefabricated metal buildings as produced by a manufacturer who is regularly engaged in fabrication of pre-engineered metal structures of type and quality indicated. All components shall be provided from one manufacturer.

WARRANTIES:

Warranty shall begin at the time of Substantial Completion.

The roofing and siding shall be warranted for a minimum of 5 years against wind damage, leakage, paint fade, chipping, peeling, attachment and rusting. Warranty shall include labor and materials for replacement of defective panels. Warranty shall not be pro-rated over 5-year period.

Finish on metal roof and wall panels, flashing, and trim will not chalk, crack, check, blister, peel, flake, chip, or loose adhesion shall be warrantied for 5 years.

PART 2 – PRODUCTS

MANUFACTURER:

Dimensions of the 12-foot by 12-foot buildings are based on Panl-Line Building System as manufactured by Butler Manufacturing Co. Dimension and sizes of the 21-foot by 16-foot buildings are based on the Parkline Building Systems, Inc. (Type AL), and VP Buildings, Inc. If an "or equal" building manufacturer is submitted and approved by the Engineer, all dimensions and clearances shall be taken as minimums for evaluation of submittal. Construction Subcontractor shall be responsible for all adjustments required to plans as a consequence of changing building manufacturer. All shop drawings and special process procedures as welding, painting and structural bolting, shall be submitted for approval and shall be stamped by a registered professional engineer licensed to practice in the State of Washington.

Type: The metal building shall be a prefabricated, weather-tight, free-standing building having a structural steel frame. The 12-foot by 12-foot buildings shall be self-framing buildings incorporating diagonal bracing. The 21-foot by 16-foot buildings shall be rigid frame in all walls with no diagonal bracing in the wall. The roof slope and the eave height shall be at as specified on Construction Drawings.

DESIGN LOADS:

The building shall be designed for the following applied loads in addition to dead load:

Roof Live Loads: Roof covering shall be designed for 20 psf uniformly distributed load.

Roof Snow Load: Ground snow load is 15 psf, $C_e = 10$, I = 0.8 designed per ASCE 7.

Wind Loads: The wind load on the structure shall be designed per ASCE 7 and DOE STD-1020-02 using a 3-second gust wind velocity of 85-mph wind speed. Design and calculate according to the ASCE 7 exposure Class "C" with an Importance Factor = 1.0.

Seismic Loads: Seismic loads shall be determined and applied in accordance with the UBC Zone 2B, Importance Factor = 1.0, Soil S_c. Out-of-plane system stability, nonstructural components, and equipment shall be evaluated using UBC 1632.

Collateral Loads: All additional dead loads, other than the weight of the metal building system, such as fire sprinklers, mechanical HVAC systems, electrical systems, and ceilings. Collateral loads shall be a minimum of 10 pounds per square foot as defined in the Metal Building Systems Manual published by the MBMA.

Maximum Deflection: Deflection shall be limited to L/240 for DL and DL+LL for all building components.

Combination of Loads: Combined loads shall be as prescribed in the UBC.

Building Code Requirement: Design building, roof system, roof overhang including support framing, roof and wall panels, and fasteners for horizontal and uplift wind loads and earthquake forces.

MATERIALS:

Hot-Rolled Structural Shapes: Conform to ASTM A36 or A529.

Tubing or Pipe: Conform to ASTM A500, Grade B; ASTM A501, or ASTM A53.

Members Fabricated from Plate or Bar Stock: 42,000 psi minimum yield strength; Conform to ASTM A529, A570, or A572.

Members Fabricated by Cold Forming: Conform to ASTM A607, Grade 50.

Galvanized Steel Sheet: Conform to ASTM A446 with G90 coating. "Class" to suit building manufacturer's standards.

STRUCTURAL FRAMING COMPONENTS:

Rigid Frames:

Rigid frames shall be hot-rolled structural steel, factory welded, and shop painted. Furnish complete with attachment plates, bearing plates, and splice members. Factory drilled for bolted field assembly.

Length of span and spacing of frames shall be as shown on Drawings except slight roof slope variations are acceptable to meet manufacturer's standard.

Wind Bracing: No "x" type rod bracing shall be used in bays where bracing would cross windows or door openings, or where the interior of the exterior walls are to be finished. Use portal frames where bracing is required at window or door openings.

Secondary Framing: Purlins, eave girts, girts, flange and sag bracings shall be "Z" or "C" roll formed sections no pre-punched for fasteners, and shall be shop prime painted. Roof purlins shall be spaced a maximum of 5-foot 0-inch O.C. Base channel, sill angle, purlin spacers; minimum 14-gauge cold-formed steel; and shall be shop prime painted.

Anchor Bolts: The anchor bolts for the rigid frames shall be carbon steel and designed by the pre-engineered building manufacturer. Location and placement shall be coordinated with the foundation rebar shown on the Drawings. Any changes in rebar placement shall be brought to the attention of the Construction Subcontractor and engineering calculations shall be provided taking into account the changed rebar location.

Bolts: Bolts shall be ASTM A325 in quantities necessary for design loads and connection details. Provide zinc- or cadmium-plated units when in direct contact with panels. Direct tension indicators shall conform to ASTM F959.

Fabrication:

Shop fabricate to the indicated size and section, complete with base plates, bearing plates, and other plates as required for erection, welded in place, and with all required holes for anchoring or connections shop drilled or punched to template dimensions.

Shop connections shall be power riveted, bolted, or welded.

Field connections shall be bolted. Install high strength threaded fasteners in accordance with "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."

Weld Construction:

Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in connecting welding work. Welding shall not be performed at the project site.

Construction General Contractor shall provide Certified Weld Inspector (CWI) to perform visual examination of all off-site welds in accordance with AWS D1.1, Section 6. Document weld acceptance on Construction Subcontractor Weld History.

Shop Painting:

Surfaces to be primed shall be cleaned of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSCP-SP1 for solvent cleaning.

Prime structural steel primary and secondary framing members with manufacturer's standard rust-inhibitive primer having over 50 percent rust-inhibitive pigment, such as organic zinc. No lead or chromate will be allowed.

Prime galvanized members, after phosphoric acid pretreatment, with zinc dust-zinc oxide primer.

ROOFING AND SIDING:

General: Provide roofing and siding sheets formed to general profile or configuration as specified. Provide flashings, closers, fillers, ridge covers, and other sheet metal accessories, factory formed of same material and finish as roofing and siding. Factory-applied baked enamel, in color selected by the Engineer.

Roof Panels:

The Interlocking-Standing Seam Roof Covering shall carry an Underwriters' Laboratories, Inc., Uplift Classification of not less than Class 90 and shall consist of material not less than 24-gauge aluminized coated steel with Kynar finish on exterior face. The panels shall be installed with the ribs upstanding and parallel to the roof slope.

All longitudinal interlocking ribs as well as any transverse end laps shall be properly sealed, according to the manufacturer's instructions, with non-drying sealant.

The roof panels shall be secured to each structural support by a steel clip concealed between the adjacent male and female ribs and fastened under that panel's weather surface. Clip shall be long enough to allow Styrofoam thermal spacer on top of purlin.

Penetrations through the roof panel by fasteners shall be limited to only those required at the rake eaves, at end laps and at the ridge. All exposed fasteners shall be fitted with weather-seal washers of hydrocarbon-based elastomer (synthetic rubber) with a compatible metal backing.

Thermal (break) spacers shall be provided continuously at each structural support to minimize thermal conductivity. The thermal spacer shall be a continuous Styrofoam strip, 3 inches by 1 inch thick.

Wall Panels Exterior:

The interlocking-ribbed wall covering shall consist of panels of not less than 24 U.S. gauge, fluoropolymer enamel finished, aluminized coated steel with male and female ribs. The wall panels shall be applied to the structural framing with the interlocking ribs toward the interior of the structure. The interlocking ribs shall be secured at the base, at each intermediate girt, and at the support at which it terminates, by means of concealed fasteners, thus eliminating any through-wall fastening. Trim finish to match wall panel.

All interior fasteners, i.e., screws, bolts and nuts, etc., shall be of carbon steel having a protective coating of either zinc or cadmium.

Interior Liner Panels: Interior wall liner panels shall be provided throughout the building on all perimeter walls. The panels shall be 24 gauge, white with concealed fasteners. All panel joints shall be provided

with sealer along the edges of each panel. The liner panels shall function as a vapor barrier. Length of panels shall be full height with no horizontal joints. finish shall be as described below.

Sealing Tape: Sealing tape shall be 100 percent solids, pressure sensitive grey polyisobutylene compound tape with release paper backing. Not less than 1/2 inch wide and 1/4 inch thick, nonsag, nontoxic, nonstaining and permanently elastic.

Joint Sealant: Joint sealant shall be one-part elastomeric; polyurethane, polysulfide, or silicon rubber as recommended by building manufacturer.

Ice Stops: Provide ice stops to prevent snow and ice damage to gutters. Ice stops shall be "ICEJAX" as manufactured by Snowjax Inc., Mechanicsburg, Pennsylvania, or approved equal. "ICEJAX" shall be adhered with Loctite "Depend", or approved equal, to metal roof panels.

Rain Gutter and Downspouts: The rain gutter shall be continuous along the eaves of the building. The gutter shall be a surface mounted type with downspout size and number as called for by the building manufacturer or as shown on the drawings. Gutter shall be minimum 5 x 5 inches in cross section. Gutter and downspouts shall be standard design as manufactured by Metal Building Manufacturer, or approved equal. Gutter shall be installed with 1/4 inch per 10-foot 0-inch slope to downspout. Factory finish to match wall panels.

INSULATION AND VAPOR RETARDER:

As specified in Section 07210, BUILDING INSULATION.

DOORS:

Steel Doors: 1-3/4-inch doors, conforming to ANSI/SDI 100, with manufacturer's standard. Provide exterior doors with top and bottom edges finished flush. Provide doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on drawings and schedules.

Exterior Doors: Unless otherwise indicated, Grade III, extra heavy duty, Model 2 (seamless) design), minimum 16 gauge galvanized steel sheet faces.

DOOR FRAMES:

Provide metal frames for doors and other openings according to ANSI/SDI 100 and of types and styles as shown on drawings and schedules. Conceal fastenings unless otherwise indicated. Frames shall be No. 14 USS gage or heavier cold-rolled steel sheet. Form exterior frames of hot dip galvanized steel. Fabricate frames with mitered and welded corners.

Available manufacturers of steel doors include the following:
AMWELD Building Products Div.
Ceco Corp.
Curries
Fenestra
Republic Builders Products Corp.
Steelcraft Mfg. Co.

Thermal-Rated (Insulating) Assemblies: At all exterior locations, provide doors, which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236 or ASTM C 976. Unless otherwise indicated, provide assemblies with maximum apparent U factor for thermal-rated assemblies is 0.24 Btu/hr (ft^2) degrees F.

HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM:

As specified in Section 15500, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM.

FIXED LOUVERS:

Material: Factory finish to match wall panels.

Free Airflow: Minimum 50 percent.

Weather Projection: Drainage-type louver.

Insect Screen: Manufacturer's standard 14-Ga to 18-Ga galvanized steel wire mesh screen.

PIPE PENETRATIONS:

For pipe penetrations through the roof use a "DEKTITE" pipe flashing unit as manufactured by ITW Buildex, or approved equal. Provide a stainless steel hose clamp for positive sealing of flashing to pipe.

WALL PENETRATIONS:

Provide opening as required by HVAC air conditioning manufacturer.

ELECTRICAL AND LIGHTING:

As specified in Section 16005, ELECTRICAL.

PART 3 – EXECUTION

ERECTION:

Framing: Erect structural framing true to line, level and plumb, rigid and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use a non-shrinking grout as specified in Section 03301, CONCRETE, to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.

Bracing:

Install diagonal rod or angle bracing in roof as required.
Diagonal/rod bracing shall not interfere with ceiling purlins.
Install portal frame bracing in sidewalls as specified.

Framed Openings: Provide shapes of proper design and size to reinforce opening and to carry loads and vibrations imposed, including equipment furnished under mechanical or electrical work. Securely attach to building structural frame.

ROOFING AND SIDING:

General:

Install panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finish from damage.

Provide weather seal under ridge cap. Flash and seal roof panels at eave, swaged joints and rake with manufacturer's standard rubber, neoprene, or other closures to exclude weather.

Roof Sheets:

Provide sealant tape at lapped joints of ribbed or fluted roof sheets, and between roof sheeting and accessories.

Apply sealant tape continuous to clean, dry surface of weather side of fastenings on end laps and on sidelaps of corrugated or nesting type, ribbed or fluted panels and elsewhere to make weatherproof to driving rains.

Wall Sheets:

Apply elastomeric sealant continuous between metal base channel (sill angle) and concrete foundation and elsewhere as necessary for waterproofing. Handle and apply sealant and backup in accordance with sealant manufacturer's recommendations.

Align bottoms of wall panels. Fasten flashings, trim around openings, etc., with self-tapping screws.

Provide small quantities of paint material and touch-up coatings damaged during construction in accordance with the manufacturer's direction.

Sheet Metal Accessories: Install louvers and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weather tight mounting.

Interior Wall Liner Panels: Install all wall liner panels as shown on the Drawings.

Certification: The Construction Subcontractor shall submit a certified statement that all standing seam metal roofing, flashings, rain gutter and downspout, wall panels, structural framing, and anchor bolts have been installed in strict accordance with the manufacturer's printed instructions and this specification.

Door Installation: Fit hollow metal doors accurately in frames, within clearance specified in SDI-100.

HARDWARE SCHEDULE:

Group No. 2:

Butts: 1-1/2 pair McKinney T4A3386 4.5 x 4.5 x BHMA 630.

Lockset: 1 Best 84-7-C-15D-S3 x BHMA 626.

Closer: 1 LCN P4041 x BHMA 673.

Rain Drip: 1 Pemko 346C.

Kick Plate: 1 SST–10 inches high by 0.05 inch thick.

Weather-stripping: 1 set Pemko 319CN x S88 x BHMA 628.

Door Bottom: 1 Pemko 430CRL x BHMA 628.

Threshold: 1 Pemko 254X4AFG x BHMA 628.

CONSTRUCTION QUALITY CONTROL:

High Strength Bolted Connections: Construction General Contractor shall provide special inspections to verify field connections with high strength bolts are installed in accordance with plans and specifications and AISC requirements.

END OF SECTION 13122

SECTION 13205 – LINED BOLTED STEEL LIQUID STORAGE TANKS Sched. B

PART 1 – GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designations only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D103	Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D130	Flexible-Membrane-Lining and Floating-Cover Materials for Potable Water Storage

ASTM INTERNATIONAL (ASTM)

ASTM A446	Steel Sheet, Zinc-Coated by the Hot-Dip Process, Structural quality
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated by the Hot-Dip Process
ASTM D413	Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate
ASTM D751	Standard Test Method for Coated Fabrics

FEDERAL STANDARDS (FS)

FS 5100	Preservation and Packing of Hand Tools; Tools and Tool Accessories for Power-Driven Metal Woodworking Machinery

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

UBC	Uniform Building Code

DESCRIPTION:

This Specification sets the minimum standards for design and construction of two lined, bolted liquid storage tanks. The tanks shall be constructed from corrugated galvanized steel panels bolted together such that no field welding or onsite coating is required. The system shall provide an interior geosynthetic fabric to protect the factory fabricated membrane liner. A tank primary and secondary liner system shall be utilized.

QUALIFICATIONS:

Tank Manufacturer: At least five tanks presently in service, of similar size and character required for this Project, and minimum of 5 years' satisfactory operation.

Tank Installer: Certified by tank manufacturer that installer is qualified to do the Work.

Registered Professional Engineer: Licensed in the state of Project with training and expertise in tank system design and installation. Able to recognize signs of potential tank system failure during the intended operating life of the tank. Able to assess and interpret information on the waste to be stored in the tank and the waste compatibility with the materials used for the tank and piping system.

Installation Inspector: Knowledge of the physical sciences and the principals of engineering acquired by a professional education and related practical experience. Trained and experienced in the proper installation of tank systems or components. Certified by tank manufacturer that the inspector is qualified and experienced in type of Work to be performed.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Statements of Qualifications:

Tank manufacturer.
Tank installer.
Registered professional engineer.
Installation inspector.

Tank Secondary and Primary Liners and Floating Cover:

Material Samples: Within 15 days from Notice to Proceed: Samples of the materials proposed for use. Submit fifty (50) sample coupons, each 8 inches by 10 inches in size, for use by the Engineer to conduct leachate compatibility testing.

Manufacturer's Data: Manufacturer's descriptive data, specifications sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Installation Plan: Submit an installation plan for the liners and cover describing the proposed methods for liner and cover deployment, panel layout, seaming, repair, and protection. The plan shall also include a quality control program for the Construction General Contractor's activities related to liner and cover materials installation.

Factory Fabrication Inspection Data (Source Quality Control): Submit documentation of factory inspection as specified herein.

Drawings:

Tank and Equipment: Detailed drawings for tanks, anchor bolts and anchor bolt chains, and equipment, such as wall construction, pipe connections, floating cover, floating cover water removal system, secondary containment system, and stilling wells for installation of level controls shall be stamped by the Registered Professional Engineer. Level controls are provided by others (see Section 13401, PICS). Drawings shall include a complete list of equipment and materials, including manufacturer’s descriptive and technical literature, and installation instructions.

Calculations:

Stamped by the Registered Professional Engineer. Complete structural stress analysis of structural components and connections and anchorage system to the concrete ringwall. Include anchor bolt reaction for all load cases and load combinations.

Design Assessment Report:

A written report providing the results of the tank system design assessment prepared and certified by the Registered Professional Engineer attesting that the tanks furnished under this section of the Specifications has sufficient structural integrity and is acceptable for the storing and treating of dangerous waste.

The assessment report shall contain the following:

Site map of the facility showing the proposed location of the tank system within the overall facility.

A sketch of the tank system including connected piping and fittings. Individual tanks shall be clearly labeled.

Structural design standards and criteria used with reference to applicable industry standards and recommended practice codes. Include all calculations for tanks and anchoring. Tank shell shall be designed based on full tank. Design parameters used in calculations shall be clearly indicated and labeled on clarifying sketches. Seismic considerations that are appropriate to the seismic risk zone shall be accounted for in the calculations.

Assessment of the compatibility of the leachate to be stored in the tank with the tank system materials. Show that the characteristics of the leachate to be stored are compatible with the material properties of the tank system, including material properties of the interior lining. Include the results of the chemical compatibility testing provided by the Engineer in this assessment.

Description and assessment of the secondary containment system, results of primary liner and secondary liner leak detection surveys, and collection of releases into the secondary containment system; compatibility of the materials in the secondary containment system with the leachate to be stored in the tank; strength of secondary containment system to withstand stresses from static head during a release, climatic conditions, nearby vehicle traffic, and daily operations; description of the leak detection system that will detect the failure of the primary containment structure or the presence of any release of leachate or accumulated liquid in the secondary containment system within 24 hours; a description of the corrosion protection for the exterior surface of the tank.

Assessment of ancillary equipment as shown on the Drawings (piping, fittings, flanges, valves, and pumps) associated with the tank including support and protection against damage and excessive stress due to excessive settlement, vibration, expansion, or contraction. Verify that peak flows and internal stresses are within the design limits specified by the manufacturer of the ancillary equipment.

The recommended inspection schedule once the tank is placed in service based on the performance of similarly designed tank systems operating under similar conditions.

A statement by the Registered Professional Engineer certifying that the tank system has been adequately designed and that the tank system has sufficient structural strength to ensure that it will not collapse, rupture, or fail under the design conditions. The certification shall include the following statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the

system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

The Registered Professional Engineer's signature and stamp must be placed below the certification statement.

SUBMITTALS–APPROVAL NOT REQUIRED:

Vendor Information (VI):

Installation: Tank Installation Instructions.

O&M Manual:

Tank Materials: Submit operating and maintenance instructions prior to completion of the Project. The manual shall include the manufacturer's cut sheets, parts lists, and a brief description of all equipment and their operating features. Maintenance instructions shall include all routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guide, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Information/Record (IR):

Submit documentation of construction quality control as specified herein.

Installation Inspection Report: A written report prepared by the Installation Inspector or the Registered Professional Engineer documenting the results of the tank system installation inspection. The installation inspection report shall contain the following:

The as-built site plan showing the location of the installed tank system.

An as-built drawing of the installed tank system including connected piping. Individual tanks shall be clearly labeled with ID numbers.

Inspection notes, photographs, and any other material used to document inspection activities.

An assessment of the tank system for structural damage or inadequate construction/installation including weld breaks, punctures, damage to protective coatings, cracks, and corrosion, and documentation of any defects discovered in materials, equipment, or installation procedures and measurements taken to correct these defects.

Documentation of tightness testing results demonstrating the tank system is tight prior to placing it in service.

A statement certifying the proper installation of the tank system liner, signed by the liner installer's representative.

A signed and dated statement by the Installation Inspector or Registered Professional Engineer certifying the proper installation of the tank system. The certification shall include the following statement:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

LEACHATE COMPATIBILITY TESTING:

The Engineer will conduct leachate compatibility testing on the tank liner and cover material samples submitted by the Construction General Contractor in accordance with EPA SW 846, Method 9090, or ASTM D5322 and D5747 procedures. At the completion of the testing, the Engineer will evaluate the testing data for conformance with the project requirements and approve or reject the material. The Engineer will provide the results of the evaluation and approval or rejection to the Construction General Contractor within 180 days after receipt of material samples. Construction General Contractor shall not order materials or proceed with fabrication until after receiving results and approval from the Engineer. Any product or material changes required as a result of inadequate leachate compatibility results will be addressed by Change Order, provided that the submitted material meets all other requirements of this section.

DELIVERY AND STORAGE:

All materials and equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity, and excessive temperature variation; and dirt, dust, or other contaminants. The tank components shall be shipped in crate(s) or pallet(s) designed to prevent physical damage to the tank coating, linings, and structural components.

WARRANTY:

The tank shall have a 3-year warranty from the date of Substantial Completion covering workmanship, materials, all steel components, and the liners and floating cover system. The warranty shall provide for correction, or, at the option of the Tank Farm Contractor, removal and replacement of Work specified in this Specification section found defective during the period of the warranty.
The Construction General Contractor shall provide the manufacturer's written warranty for the liners and cover. The warranty shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the liner and cover manufacturer. The warranty shall guaranty the liner and cover material for the above-stated period against:

MANUFACTURING DEFECTS.

Deterioration due to ozone, ultraviolet, and other exposure to the elements, including the stored leachate.

Defects in material and factory seams.

Defects resulting from installation.

PART 2 – PRODUCTS

MANUFACTURER:

Dimensions are based on bolted steel tank as manufactured by Environetics, Inc. All dimensions and clearances shall be taken as minimum if an "or equal" tank manufacturer is submitted and approved by the Engineer. Construction General Contractor shall be responsible for all adjustments required to Drawings as a consequence of changing tank manufacturer.

STANDARD PRODUCTS:

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site. The items specified under this section shall be furnished by constructors having experience and regular practice in the design, fabrication, and construction of steel tanks.

TANK SIZE REQUIREMENTS:

Number of Tanks Required: Two.

Required Diameter: 101.46 feet.

Required Height: 8.17 feet.

Cover Required: Yes.

Leachate Volume: 375,000 gallons.

Top Capacity Level (TCL): 6.20 feet above tank floor.

DESIGN:

Design shall be in accordance with the requirements of AWWA D103.

Design Loads:

Specific Gravity: The tank shall be designed for liquids with a specific gravity of 1.00.

Earthquake: The tank shall be designed for Seismic Zone 2B per UBC and AWWA D103, site amplification soil profile C, I=1.0. For seismic, use leachate top capacity level (TCL).
Wind Force: The tank shall be designed to the greater requirements of a 100-mph wind with pressure loads as calculated with AWWA D103 or an 85-mph with pressure loads determined using ASCE 7, 1998. Wind force calculations shall include wind analysis with an empty tank case as well as a full tank case.

Hydrostatic Pressure: Design tank for static pressure to top of tank shell height.

Leachate Characteristics for Leachate Compatibility Testing:

Based on previous testing, the synthetic leachate for leachate compatibility testing of the tank liner material will have the following characteristics:

Chemical Compound	Concentration (g/l)
$NaNO_3$	185.0
Na_2SO_4	11.86
NaF	1.46
Na_2CO_3	3.45
$NaHCO_3$	2.44
pH	9.2 ± 0.1, using NaOH or HNO_3 as required

TANK COMPONENTS:

The tank and liner system shall consist of the following components: Corrugated steel wall panels with anchor embedded in concrete ringwall, geotextile base and wall buffer, secondary containment liner, drainage net, primary liner and floating cover, pipe connections, tank ladder, and piping for level and leak detection measurement.

Corrugated Steel Wall Panels:

The tank walls shall be constructed from individual rings of corrugated, hot-dip galvanized steel, mill-rolled to finished diameter. Sheet materials shall be ASTM A446, Grade D; or equal. Sheet materials shall be mill galvanized to ASTM A525, Class G90 standards, or equal. Shell plate thickness shall be based on AWWA D103 structural requirements. Wall plate thickness shall be a minimum of 12 gauge. Provide wind stiffeners as required by design.

Sheet materials shall receive an electrostatically applied, thermally cured, polyester powder coat finish. The coating shall be applied in two coats with a minimum dry film thickness of 5.0 mils. The finished coating shall be white in color.

Anchor Bolts: Shall conform to the requirements of AWWA D103.

Bolted Joints: Structural bolts conform to the requirements of AWWA D103 and shall be zinc electroplated. Bolted joints shall utilize a minimum two vertical rows as required to withstand structural loads.

Geotextile Base and Wall Buffer: An 8-ounce geotextile polypropylene nonwoven needle-punched fabric shall be placed on the tank floor and wall as a buffer for the liner. The fabric shall be designed to protect the liner from irregular surfaces on the tank wall. The material properties shall conform with the following:

Fabric Property	Unit	Test Method	Value
Grab Tensile Strength	lb	ASTM D4632	203
Grab Elongation	%	ASTM D4632	50
Puncture Strength	lb	ASTM D4833	130
Mullen Burst	psi	ASTM D3786	400
Trapezoid Tear Strength	lb	ASTM D4533	80
Permittivity[a]	sec^{-1}	ASTM D4491	1.5
Water Flow Rate[a]	gpm/sq ft	ASTM D4491	110
AOS	sieve	ASTM D4751	100
UV Resistance	% strength @ 500 hrs	ASTM D4355	70

(a) Minimum average roll values (MARV) for these secondary physical properties shall not exceed specified values.

Tank Secondary and Primary Liners and Floating Cover:

The liners and floating cover shall be fabricated from polyester reinforced polymeric alloy. Sheet materials shall have UV resistance and weathering qualities and conform to the following properties:

Physical Property	Physical Values	Test Method
Thickness	30.0 mils min.	ASTM D751
Weight	30.0 ± 2 oz/yd^2	ASTM D751
Tear Strength	35/35 lb_f min.	ASTM D4533, Trapezoid Tear
Breaking Yield Strength	550/550 lb_f min.	ASTM D751, Grab Tensile
Low Temperature	Pass @ -30ºF	ASTM D2136, 4 hr – 1/8" mandrel
Dimensional Stability	1.5% max.	ASTM D1204, 212ºF – 1 h reach direction
Adhesion - Heat Sealed	35 lb_f/2 in min.	ASTM D751, Dielectric Weld
Seam Strength	Dead Load - Seam Shear 2 in seam, 4 hr, 1 in strip 210 lb_f @ 70ºF 105 lb_f @ 160ºF	ASTM D751
Bursting Strength Ball Tip	650 lb_f min. 800 lb_f typical	ASTM D751
Hydrostatic Resistance	800 psi min.	ASTM D751 Method A
Blocking Resistance	# 2 Rating max.	ASTM D751 (180ºF/82ºC)
Adhesion - Ply or Film Tearing Bond	15 lb_f/in min.	ASTM D413
Bonded Seam Strength	550 lb_f min.	ASTM D751 as modified by NSF 54

Physical Property	Physical Values	Test Method
Abrasion Resistance before fabric exposure 50 mg/100 cycles max weight loss	2,000 cycles (min.) (H-18 Wheel, 1,000 g load)	ASTM D3389
Weathering Resistance	8,000 hrs (min.) –	ASTM G23 (Carbon-Arc)
No appreciable changes or stiffening or cracking of coating		
Water Absorption	0.025 kg/m2 max.	ASTM D471 Section 12, @ 70ºF/21ºC
	7 days, 0.14 kg/m2 max.	@ 212ºF/100ºC
Wicking Shelter-Rite® Procedure	1/8 in max.	
Puncture Resistance	250 lbf min.	ASTM D4833
Coefficient of Thermal	8 x 10^{-6} in/in/ºF max.	ASTM D696

EXPANSION/CONTRACTION

Secondary and Primary Tank Liners: Shall be fabricated in a controlled factory environment into complete liners or large prefabricated panels. Size shall be limited to 3,000 pounds for ease of installation.

Tank Liner Source Quality Control: The tank liner(s) and cover shall be fabricated from standard width sheeting into a full-size fitted liner by means of minimum 1-inch wide dielectric and 2-inch wide thermal welds. The liner(s) and cover shall be thoroughly inspected by the fabricator for flaws in materials or fabrication prior to shipment. Inspection shall be performed by 100 percent visual inspection and proprietary inflation-light test methods. Construction General Contractor shall provide documentation of factory inspections to the Construction Manager.

Floating Cover: The cover shall be designed to comply with applicable AWWA D103 design standards. The cover shall incorporate closed cell polyethylene foam floatation elements in cover membrane pockets to provide the required buoyancy, drainage, and wind stability. The cover shall incorporate a center vent to evacuate air during fill cycle. The manufacturers shall provide a pump system with pump to remove excess surface water. Floating cover shall drain towards the perimeter of the tank where excess water may be collected and pumped out. Cover vent shall include a base plate to prevent tipping due to wind or snow load.

Drainage Net: The floor area of the tank shall be covered with fitted panels of high density polyethylene (HDPE) drainage net with a geotextile laminated to both sides of the drainage net to prevent clogging and to provide a cushion for the HDPE drainage net against the tank liners. The drainage net shall be installed between the primary and secondary liners to convey liquids between the liners to a leak detection sump. Properties for the drainage net and geotextile are as follows:

Physical Properties	Test Method	Physical Value
Combined:		
Transmissivity, m/sec	ASTM D4716	4×10^{-5}
Drainage Net Component:		
Transmissivity, m/sec	ASTM D4716	1×10^{-3}
Thickness, mill	ASTM D1777	200
Density g/cm^3	ASTM D105	0.94
Tensile Strength, lb/in	ASTM D5034/5035	45
Carbon Black Content, %	ASTM D1603	2.0
Geotextile Component:		8 oz/yd^2
Thickness, mill	ASTM D5199	90
Grab Tensile, lb	ASTM D4632	210
Puncture Strength, lb	ASTM D4833	135 ± 5 lbs
AOS, US Sieve	ASTM D4751	80
Flow Rate, gpm/ft	ASTM D4491	110 ± 10 gpm/ft
UV Resistance, % retained	ASTM D4355	70

Pipe Connections: Pipe fittings and connections shall be in accordance with manufacturer's requirements for double containment connections. Location of pipe connections shall be as shown on the Drawings.

Tank Ladder: Provide a hot-dipped galvanized steel ladder for access to the floating cover pump. The ladder shall be attached at the top of the tank wall and at its base to the concrete ringwall. The ladder shall be of sufficient height to allow viewing of the floating cover system and its pump. The ladder shall be located adjacent to the tank level element installation.

Tank Level and Leak Detection Measurement:

Provide as part of tank construction two 2-inch diameter (Schedule 80 PVC) internal (stilling wells) that extend the whole interior operating height of tank, for the purpose of facilitating the installation of a submersible pressure transmitter (in one pipe), and a multipoint level sensor (in the other pipe). Level measurement instrumentation provided under Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), and installed by Construction General Contractor under this section.

Construction General Contractor shall furnish and install all necessary equipment and personnel to properly support installation of measurement devices (i.e., PVC flanges, straps, and gaskets).

Foundation: Tank shell to bear on a Type 1 concrete ringwall per AWWA D103 as shown on the Drawings. A 1-1/2-inch minimum space between the tank bottom and the top of the ringwall shall be filled with a nonshrink grout as specified in Section 03301, CONCRETE. Cane fiber joint filler shall not be used. Ringwall design is shown on Drawings.

PART 3 – EXECUTION

GENERAL:

Tank construction shall be in accordance with AWWA D103.

TANK INSTALLATION:

Field erection of lined bolted steel tanks, including, but not limited to, shell plates, pipe connections, awning, primary and secondary containment, and floating cover, shall be in strict accordance with the manufacturer's recommendations including their guidance on environmental factors that could affect the tank installation.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall establish and maintain a quality control system to assure compliance with contract requirements and shall maintain records of its quality control for all operations including, but not limited to the following:

Inspection of materials delivered to project site against approved material data.

Storage and handling of materials.

Finished appearance.

Completion of required testing.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the Construction Manager within 24 hours following the inspection or test.

Tank System Installation Inspection:

The Construction General Contractor shall provide the services of an Installation Inspector or Registered Professional Engineer to provide full-time supervision of the installation of the storage tanks. No work shall be performed without the presence in the field of the Installation Inspector or Registered Professional Engineer. The Installation Inspector or Registered Professional Engineer shall observe and verify that correct materials and procedures are used for the following activities:
Visual inspection and testing.
Subgrade and foundation preparation.
Placement and compaction of backfill.
Placement of reinforcing steel and anchor bolts.
Concrete placement.
Placement of shop-fabricated tank parts.
Erection of field-erected tank parts.
Installation of tank liner systems. Tank liner inspection requirements are specified herein.
Installation of piping, pumping, and other ancillary equipment.
Tightness testing.

Tank Liner Inspection:

Visual Inspection: 100 percent visual inspection along all seams of the liners.

Air Jet Inspection: 100 percent air jet inspection of all seams.

Any required repairs shall be corrected in accordance with the manufacturer's recommendations. Results of all testing shall be provided to the Construction Manager.

Electronic Leak Location Survey: Prior to installing the floating cover, complete an electronic leak location survey of the secondary and primary liners.

Floating Cover Drainage Test:

Add water on floating cover to test that water drains towards the perimeter. Manufacturer to revise ballast if water does not drain to allow removal of excess water. Demonstrate proper operation of floating cover pump system to remove excess water.

Tank Tightness Testing:

Upon completion of tank installation, the tank shall be visually inspected for any signs of physical damage. Any questionable areas shall be repaired in accordance with the manufacturer's instructions. The tank shall be filled with water and let stand for a period of not less than 2 days. The Construction General Contractor shall maintain a level not less than 7.2 feet for the duration of 2 days. Following the 2 days, the Construction General Contractor shall cyclically change the tank water level at a constant rate from 0.5 foot to 7.2 feet for four cycles over the next 28 days. During the 30 days, there shall be no signs of leakage from a defect in the primary liner to the secondary containment system of the tank. Any leaks discovered by this test shall be corrected by the Construction General Contractor in accordance with the manufacturer's recommendations. The tank system shall be successfully tested before it is accepted. Results of all testing shall be provided to the Construction Manager.

END OF SECTION 13205

SECTION 13401 – PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) Sched. B

PART 1 – GENERAL

UL AND NRTL COMPLIANCE:

Materials manufactured within the scope of UL or another nationally recognized testing laboratory (NRTL) shall conform to UL or NRTL standards and have an applied UL or NRTL listing mark. References to UL throughout this section imply conformity with UL or NRTL standards and guidelines.

PICS control panels shall be manufactured, assembled, tested, approved, and clearly labeled in accordance with UL 508A when required, prior to delivery to construction site.

Approval by Authority Having Jurisdiction (AHJ): As specified in Section 16005, ELECTRICAL.

WORK INCLUDES:

Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Tank Farm Contractor training for a complete Process Instrumentation and Control System for plant.

Detailed Design: PICS as shown and specified includes functional and performance requirements and component specifications. Complete detailed PICS design.

Major Cell No. 1 and Cell No. 2 components and controls to integrate into PICS and to program include:

Crest Pad Building Control Panel, PLC, and Operator Interface Assemblies.

Crest Pad Building Sump, Combined Sump, Leachate Tank, and Leachate Transfer Building Transfer Pump Local Control Panel Assemblies.

Leachate Collection and Removal, and Leak Detection System Pump Control.

Leachate Collection and Removal, and Leak Detection System Pump Discharge Flow and Flow Totalization.

Leachate Collection and Removal System Continuous Level Measurement.

Leak Detection System Continuous Level Measurement.

Leachate Storage Tank Continuous Level Measurement.

Leachate Storage Tank, Crest Pad Building Sump, Carrier Pipe, and Combined Sump Leak Detection Chamber Discrete Level Measurement.

Crest Pad Building Sump Discrete Level Measurement, and Pump Control.

Combined Sump Discrete Level Measurement, and Pump Control.

Interlock Control between Crest Pad Building Sump and Leachate Collection, and Removal and Leak Detection System Pump Controls.

Crest Pad and Leachate Transfer Building Continuous Temperature Measurement.

Leachate Transfer Pump Control and Flow Measurement, and Flow Totalization.

Crest Pad Building Discrete Power Measurement.

DEFINITIONS:

ABBREVIATIONS:

CAT: Construction Acceptance Test.

CP: Control Panel.

FDT: Factory Demonstration Test.

LCP: Local Control Panel.

MCC: Motor Control Center.

OIU: Operator Interface Unit.

PCT: PICS Continuity Test.

PFT: PICS Functionality Test.

PLC: Programmable Logic Controller.

SLC: Small Programmable Logic Controller.

Rising/Falling: Terms used to define actions of discrete devices about their set points.

Rising: Contacts change state when an increasing process variable rises through set point.

Falling: Contacts change state when a decreasing process variable falls through set point.

Signal Types:

Analog Signals, Current Type:

4 to 20 mA dc signals conforming to ISA S50.1.

Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:

Transmitter Type: Number 2, two-wire.

Transmitter Load Resistance Capacity: Class L.

Fully isolated transmitters and receivers.

Analog Signals, Voltage Type: 1 to 5 volts dc within control panels only.

Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.

Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

Instrument Tag Numbers: In accordance with DOE-RL Standards.

SUBMITTALS–APPROVAL REQUIRED

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

General:

Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.

Identify proposed items and options. Identify installed spares and other provisions for future work (e.g., reserved panel space; unused components, wiring, and terminals).

Bill of Materials: List of required equipment.

Group equipment items as follows:

I&C Components: By component identification code.

Other Equipment: By equipment type.

Data Included:

Equipment tag number.

Description.

Manufacturer, complete model number, and all options not defined by model number.
Quantity supplied.
Component identification code where applicable.

Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:

Catalog information, mark to identify proposed items and options.
Descriptive literature.
External power and signal connections.
Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

Component Data Sheets: Data sheets for I&C components.

Format and Level of Detail: In accordance with ISA-S20.

Include component type identification code and tag number on data sheet.

Specific features and configuration data for each component:

Location or service.
Manufacturer and complete model number.
Size and scale range.
Set points.
Materials of construction.
Options included.
Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

Panel Construction Drawings:

Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.

Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.

Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.

Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.

Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.

Panel Control Diagrams: For discrete control and power circuits.

Diagram Type: Ladder diagrams. Include devices, related to discrete functions that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.

Item Identification: Identify each item with attributes listed.

Wires: Wire number and color. Cable number if part of multiconductor cable.

Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

Discrete Components:

Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (e.g., Sump Level High).

Relay Coils:

Tag number and its function.

On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.

Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

Show each circuit individually. No "typical" diagrams or "typical" wire lists will be permitted.

Ground wires, surge protectors, and connections.

Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.

Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.

Conform to the ISA S5.4 Standards.

Drawing Size: Individual 11-inch by 17-inch sheet for each loop.

Divide each loop diagram into areas for panel face, back-of-panel, and field.

Show:

Terminal numbers, location of dc power supply, and location of common dropping resistors.

Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

Tabular summary on each diagram.

Transmitting Instruments: Output capability.

Receiving Instruments: Input impedance.

Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.

Total loop impedance.

Reserve output capacity.

Conduit and cable schedule names.

Interconnecting Wiring Diagrams:

Diagrams, device designations, and symbols in accordance with NEMA ICS 1.

Diagrams shall bear electrical Construction Subcontractor's signature attesting diagrams have been coordinated with Division 16, ELECTRICAL.

Show:

Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.

Component and panel terminal board identification numbers, and external wire and cable numbers.

Circuit names matching Conduit and Cable Schedule.

Intermediate terminations between field elements and panels for, e.g., to terminal junction boxes and pull boxes.

Pull boxes.

Factory Demonstration Test (FDT): Provide FDT documentation for control panels.

Installation Details: Include modifications or further details required to adequately define installation of I&C components.

List of spares, expendables, test equipment and tools.

SUBMITTALS–APPROVAL NOT REQUIRED

Information/Record (IR): For PICS equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

Tank Farm Contractor Training Plan: In accordance with Article TRAINING.

Construction Quality Control Test Data: Provide documentation of PICS Continuity Test (PCT) and PICS Functionality Test (PFT).

Operation and Maintenance (O&M) Manuals:

Content and Format:

Complete sets O&M manuals, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.

Final versions of Legend and Abbreviation Lists.

Include:

Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PICS design.

Refer to paragraph Shop Drawings for the following items:

Bill of Materials.
Catalog Cuts.
Component Data Sheets.
Panel Control Diagrams.
Panel Wiring Diagrams, one reproducible copy.
Loop Diagrams, one reproducible copy.
Interconnecting Wiring Diagrams, one reproducible copy.
Device O&M manuals for components, electrical devices, and mechanical devices include:
Operations procedures.
Installation requirements and procedures.

Maintenance requirements and procedures including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Troubleshooting procedures.

Calibration procedures.

Internal schematic and wiring diagrams.

Component Calibration Sheets from field quality control calibrations.

List of spares, expendables, test equipment and tools provided.

List of additional spares, expendables, test equipment and tools recommended.

Factory Demonstration Test (FDT), PICS Continuity Test (PCT), and PICS Functionality Test (PFT) Submittals:

Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.

Final Test Procedures: Proposed test procedures, forms, and checklists.

Test Documentation: Copy of signed off test procedures when tests are completed.

Application Software Submittal and Design Workshops:

Location: There shall be a minimum of six (6) workshops held at the Tank Farm Contractor's facility (or by video and audio conferencing) during the course of the project.

Objective: To provide a vehicle by which the Tank Farm Contractor is able review and comment on PLC, OIU, communication hardware, standard software, and application software submittals and application software development.

Documentation: Application software supplier shall summarize resolutions reached in each workshop, including cost and schedule impacts and distribute copies to Tank Farm Contractor.

Order and minimum topics to be covered in each workshop:

Applications Software Design Workshop (kick off) that establishes project processes, including:

Workshop objectives.

Submittal process.

Review Work Sequence and schedule.

Loop Specifications, P&ID Review Workshop:

Application Software Supplier use P&IDs and Specifications to present how the proposed control system design and Applications Software will meet the functional requirements specified herein.

At the completion of workshop Applications Software Supplier modifies as necessary Loop Specifications.

Submit finalized Loop Specification along with an outline of any application software cost and schedule impacts.

PLC Software Standards Submittal Workshop: PLC Software Standards shall be developed in a Software Standards Workshop. Ladder diagram standards for commonly used functions, including the following:

Objective: To develop, implement, and review implementation of PLC Software Standards in ladder logic programming.

Ladder diagram standards for commonly used functions, including the following:

High and low process variable alarm checking.
Instrument failure alarm detection.
Equipment start/stop control.
Equipment failure detection.
Equipment run time.
Leak detection and equipment interlocks.

Signal filtering.
Flow totalization.
Alarm routines.
Interface with OIU.

Memory mapping, data transfer (read/write, remote set point adjustment, pump control and alarm management).

Submit for review ladder logic programming for each PLC including: descriptive ladder logic, cross references, memory map and point databases.

OIU Standard Workshop:

Objective: To develop, implement, and review implementation of OIU standards with Tank Farm Contractor.

Design Products and Topics to be Finalized:

OIU and PLC integration.
OIU tag naming conventions.
Process, set point, and runtime graphics.
Display paging and navigation.

Dynamic Objects: Pumps, valves, gates, compressors, etc.

Equipment control through pop up windows.
General data entry through the OIU.

Dynamic Objects: Pumps, valves, gates, process indicators, indicators with alarms, data entry, controller face plate, and tanks.

Security.
Alarm Management.

Minimum OIU Design Products and Topics to be Finalized for Each OIU:

Eight (8) Process Graphics.
Eight (8) Pop-Up Equipment Operation Control Graphics.
One (1) Alarm Summary Process Control Graphic.
One (1) Alarm History Process Control Graphic.
One (1) Equipment Runtime Process Control Graphic.
One (1) Analog Process Summary Control Graphic.

Submit for review OIU programming and development for each OIU computer including: memory mapping, database structures, graphic displays, and alarms.

DELIVERY, STORAGE, AND HANDLING:

Provide site and warehouse storage facilities for PICS equipment.

Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

Cover panels and other elements that are exposed to dusty construction environments.

Electrical equipment (valves, instruments, sensors, enclosures) shall be wired complete and in accordance with the manufacturer's wiring diagrams and instructions.

Completed wiring diagrams shall be incorporated in the O&M submittal.

ENVIRONMENTAL REQUIREMENTS:

Standard Environmental Requirements: Unless otherwise noted, provide equipment for continuous operation in these environments:

Freestanding Panel and Consoles:

Inside: NEMA 12.

Smaller Panels and Assemblies (that are not Freestanding):

Inside: NEMA 4X.

All Other Locations: NEMA 4X.

Field Elements: Outside.

Special Environmental Requirements: Design panels for continuous operation in environments listed:

Building Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Transfer Pump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Leachate Transfer Buildings.

Leachate Storage Tank Local Control Panel to be installed outdoors adjacent to Cell No. 1 and Cell No. 2 Leachate Storage Tanks.

Combined Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Environmental Design Requirements: Environmental conditions are defined below:

Inside:

Temperature: 10 to 30 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous.

Outside:

Temperature: Minus 40 to 40 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous (except for interior of Combined Sump Assemblies).

Snow Accumulation: 5 inches.

SEQUENCING AND SCHEDULING:

Activity Completion: The following is a list of key activities and their completion criteria:

Shop Drawings: Reviewed and approved.

Factory Demonstration Testing of Control Panels: Reviewed and accepted.

Hardware Delivery: Hardware delivered to site and inventoried by Tank Farm Contractor.

PCT: Completed and required test documentation accepted.

PFT: Completed and required test documentation accepted.

PICS Substantial Completion: When Construction Manager issues Certificate of Substantial Completion.

Prerequisites:

All PICS Submittals have been completed.

PICS has successfully completed FDT and PFT.

Tank Farm Contractor training plan is on schedule.

All spares, expendables, and test equipment have been delivered to Tank Farm Contractor.

PICS Acceptance: When Construction Manager issues a written notice of Final Payment and Acceptance.

Prerequisites:

Certificate of Substantial Completion issued for PICS.

Punch-list items completed.

Final revisions to O&M manuals accepted.

Maintenance service agreements for PICS accepted by which shall satisfy the following requirements:

Duration of 2 years unless negotiated with Tank Farm Contractor.

Start on date of PICS acceptance, as identified in Section 13401, PICS, Article SEQUENCING AND SCHEDULING, Paragraph PICS Acceptance.

Performed by factory trained service engineers with experience on PICS systems to be maintained.

All materials and labor for preventive maintenance and visit site bimonthly.

All materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Response Time: Service engineer shall be onsite within 24 hours of request by Tank Farm Contractor.

Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.

Repair or replace all components or software found to be faulty.

Replace and restock within 1 month, onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.

Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each visit to site.

Telephone Support: Coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Software Subscription: 2-year support per Section 13401, PICS, Supplements.

Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	**Prerequisites and Lead Times**
Submittal reviews by Engineer and Tank Farm Contractor	Tank Farm Contractor acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly.	Associated shop drawing Submittals completed
Shipment	Completion of PICS Shop Drawing and Quality Control Submittals, preliminary O&M manuals, and Factory Demonstration Testing.
PCT	PCT procedures completed; notice 3 weeks prior to start.
Tank Farm	Tank Farm Contractor training plan completed.
Contractor Training	
PFT	Startup, Tank Farm Contractor training, and PFT procedures completed; notice 4 weeks prior to start.

PART 2 – PRODUCTS

GENERAL:

The general functions of the PICS are as depicted on the Drawings. The PICS Contractor shall provide a full-featured system that is complete, calibrated, and fully operational.

Like Equipment Items:

Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

LOOP SPECIFICATIONS:

Location: Article SUPPLEMENTS.

Organization: By unit process and loop number.

Functional Requirements for Control Loops:

Shown on Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

Supplemented by Loop Specifications.

Subheadings for Each Loop:

Functions: Clarifies functional performance of loop, including abstract of interlocks.

Components: Lists major components for each loop. Information listed include: Tag numbers.

Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article SUPPLEMENTS.

Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, set points, and controller options.

I&C COMPONENTS:

Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article SUPPLEMENTS. Furnish all equipment that is necessary to achieve required loop performance.

Component Specifications: Generalized specifications for each type of component are located in Article SUPPLEMENTS.

NAMEPLATES AND TAGS:

Panel Nameplates: Enclosure identification located on the enclosure face.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 1/2-inch white on black background, unless otherwise noted.

Component Nameplates—Panel Face: Component identification located on panel face under or near component.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 3/16-inch white on black background, unless otherwise noted.

Component Nameplates—Back of Panel: Component identification located near component inside of enclosure.

Inscription: Component tag number.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:

Inscription: Refer to:

Table under paragraph Standard Pushbutton Colors and Inscriptions.
Table under paragraph Standard Light Colors and Inscriptions.

P&IDs in Drawings.

Materials: Engraved plastic, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.

Letters: Black on gray or white background.

Service Legends: Component identification nameplate located on face of component.

Inscription: As shown.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Nametags: Component identification for field devices.

Inscription: Component tag number.

Materials: 16-gauge, Type 304 stainless steel.

Letters: 3/16-inch imposed.

Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

ELECTRICAL REQUIREMENTS:

In accordance with Division 16, ELECTRICAL.
I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

Wires Within Enclosures:

ac Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current to be carried, but not less than No. 14 AWG.

Analog Signal Circuits:

Type: 600-volt stranded copper, twisted shielded pairs.

Size: No. 16 AWG, minimum.

Other dc Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current carried, but not less than No. 18 AWG.

Special Signal Circuits: Use manufacturer's standard cables.

Wire Identification: Numbered and tagged at each termination.

Wire Tags: Snap-on or slip-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

Wires entering or leaving enclosures, terminate and identify as follows:

Analog and discrete signal, terminate at numbered terminal blocks.
Special signals, terminated using manufacturer's standard connectors.
Identify wiring in accordance with Division 16, ELECTRICAL.

Terminal Blocks for Enclosures:

Wire spare PLC I/O points to terminal blocks.
One wire per terminal for field wires entering enclosures.
Maximum of two wires per terminal for 18-WG wire for internal enclosure wiring.

Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.

General:

Connection Type: Screw compression clamp.

Compression Clamp:

Complies with DIN-VDE 0611.
Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.
Guides strands of wire into terminal.

Screws: Hardened steel, captive and self-locking.

Current Bar: Copper or treated brass.

Insulation:

Thermoplastic rated for minus 55 to plus 110 degree C.
Two funneled shaped inputs to facilitate wire entry.

Mounting:

Standard DIN rail.
Terminal block can be extracted from an assembly without displacing adjacent blocks.

End Stops: Minimum of one at each end of rail.

Wire Preparation: Stripping only permitted.

Jumpers: Allow jumper installation without loss of space on terminal or rail.

Marking System:

Terminal number shown on both sides of terminal block.
Allow use of preprinted and field marked tags.
Terminal strip numbers shown on end stops.
Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

Terminal Block, General-Purpose:

Rated Voltage: 600V ac.

Rated Current: 30 amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Spacing: 0.25 inch, maximum.

Test Sockets: One screw test socket 0.079-inch diameter.

Manufacturer and Product: Entrelec; Type M4/6.T.

Terminal Block, Ground:

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Green and yellow body.

Spacing: 0.25 inch, maximum.

Grounding: Ground terminal blocks electrically grounded to the mounting rail.

Manufacturer and Product: Entrelec; Type M4/6.P.

Terminal Block, Blade Disconnect Switch:

Rated Voltage: 600V ac.

Rated Current: 10-amp.

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Grey body, orange switch.

Spacing: 0.25 inch, maximum.

Manufacturer and Product: Entrelec; Type M4/6.SN.T.

Terminal Block, Fused, 24V dc:

Rated Voltage: 600V dc.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: LED diode 24V dc.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac:

Rated Voltage: 600V ac.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: Neon Lamp 110V ac.

Leakage Current: 1.8 mA, maximum.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac, High Current:

Rated Voltage: 600V ac.

Rated Current: 35 amps.

Wire Size: No. 18 to No. 8 AWG.

Rated Wire Size: No. 8 AWG.

Color: Grey.

Fuse: 13/32 inch by 1.5 inches.

Spacing: 0.95 inch, maximum.

Manufacturer and Product: Entrelec; Type MB10/24.SF.

Grounding of Enclosures:

Furnish copper isolated ground bus. Take car to ensure that this bus is connected to the safety ground bus at only one point.

Single Point Ground for Each Analog Loop:

Group and connect shields in following locations:
Control Panel.
Ground terminal block rails to ground bus.

Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another and where required to provide proper function. Do not wire in series instruments on different panels, cabinets, or enclosures.

Power Distribution Within Panels:

Feeder Circuits:

One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
Make provisions for feeder circuit conduit entry.
Furnish terminal blocks for termination of wires.

Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.

Locate to provide clear view of and access to breakers when door is open.

Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.

Branch Circuit Breaker: Select size of circuit breaker to suit load at 250V ac.

Breaker Manufacturers and Products: Allen-Bradley 1492-GH.

Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:

Devices on Single Circuit: 20, maximum.

Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.

Branch Circuit Loading: 12 amperes continuous, maximum.

Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.

Provide 120-volt ac plugmold for panel components with line cords.

Signal Distribution:

Within Panels: 4 to 20 mA dc signals may be distributed as 1 to 5V dc.

Outside Panels: Isolated 4 to 20 mA dc only.

All signal wiring in twisted shielded pairs.

Between Panels: 4 to 20 mA dc signals isolated by current signal isolators.

Signal Switching:

Use dry circuit type relays or switches.
No interruption of 4 to 20 mA loops during switching.

Switching Transients in Associated Signal Circuit:

4 to 20 mA dc Signals: 0.2 mA, maximum.

1 to 5V dc Signals: 0.05V, maximum.

Current Signal Isolators:

Solid state three- and four-way isolation of the input signal, two output signals, and external power supply.

Features:

Zero and span trim adjustments using 15-turn potentiometers.
Calibration independent of load.

Signal Interface:

Input: 4 to 20 mA dc maximum impedance: 75 ohms.

Output: Two 4 to 20 mA dc. Capable of drives output load impedance up to 1,050 ohms independent of supply voltage to isolator.

Enclosure: NEMA 1, unless otherwise noted.

Mounting: DIN rail, unless otherwise noted.

Power: 115V ac, unless otherwise noted.

Manufacturer: Moore ECT Isolators; or approved equal.

Intrinsic Safety:

Programmable three-channel switching amplifier with intrinsically safe input circuits, used to isolate and transfer discrete signals from Class I, Class II, or Class III hazardous location to a nonhazardous location.

Inputs: Three-channel dry contact inputs to switching amplifier.

Outputs: Three-channel SPDT dry relay contact outputs, each selectable to be (N.O.) or (N.C.) Output function dependent upon input condition.

Indications: Two-color switching status LED for each channel. “Yellow” LED when output relay is energized. “Green” LED with power ON status, “Red” LED for Fault Condition.

Supply Voltage: 10-30 VDC.

Power Consumption: >2 watts.

Output contact Ratings: 500 VA/60W.

Approvals and Certifications: FM approved, and CSA Certified.

Manufacturer and Product: TURK MD13-231Ex0-R/24VDC or equal.

Relays:

General:

Relay Mounting: Plug-in type socket.

Relay Enclosure: Furnish dust cover.

Socket Type: Screw terminal interface with wiring.

Socket Mounting: Rail.

Provide hold-down clips.

Control Circuit Switching Relay, Nonlatching:

Type: Compact general-purpose plug-in.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 28V dc or 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 1.2 watts (dc), 1.75VA (ac).

Expected Mechanical Life: 10,000,000 operations.

Expected Electrical Life at Rated Load: 100,000 operations.

Indication Type: Neon or LED indicator lamp.

Push to test button.

Manufacturer and Product: Allen-Bradley; 700-HA Series.

For all 11-pin relays use Allen-Bradley 700-HN203. For 8-pin relays, use Allen-Bradley 700-HN203.

Control Circuit Switching Relay, Latching:

Type: Dual coil mechanical latching relay.

Contact Arrangement: 2 Form C contacts.

Contact Rating: 10A at 28V dc or 120V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 2.7 watts (dc), 5.3VA (ac).

Expected Mechanical Life: 500,000 operations.

Expected Electrical Life at Rated Load: 50,000 operations.

Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

Control Circuit Switching Relay, Time Delay:

Type: Adjustable time delay relay.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Operating Temperature: Minus 10 to 55 degrees C.

Repeatability: Plus or minus 0.5 percent.

Timing Module: Solid state multifunction plug-in module. Plugs into socket to add timing feature to general purpose relay.

Manufacturer and Products: Allen-Bradley 700-HT1 for ac, 700-HT2 for dc.

Power Supplies:

Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with plus or minus 0.05 percent voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

Provide output over voltage and over current protective devices to:

Protect instruments from damage due to power supply failure.
Protect power supply from damage due to external failure.

Enclosures: NEMA 1 in accordance with NEMA 250.

Mount such that dissipated heat does not adversely affect other components.

Fuses: For each dc supply line to each individual two-wire transmitter.

Type: Indicating.

Mount so fuses can be easily seen and replaced.

Resistors: All resistors used to derive a 1-5V dc signal from a 4-20 mA dc signal shall be 250 ohm, ±1 percent, 3 watts, axial lead, non-inductive wire wound, welded construction, silicone coated, 1,000V ac dielectric. Vishay-Dale RS-2B-NS or equal. 250 ohms is a standard value in this line, and use of a resistance other that 250 ohms is not acceptable.

Internal Panel Lights for Freestanding Panels:

Type: Switched 100-watt fluorescent back-of-panel lights.

Quantity: One light for every 4 feet of panel width.

Mounting: Inside and in the top of back-of-panel area.

Protective metal shield for lights.

Service Outlets for Freestanding Panels:

Type: Three-wire, 120-volt, 15-ampere, GFI duplex receptacles.

Quantity:

For Panels 4 Feet Wide and Smaller: One.

For Panels Wider Than 4 Feet: One for every 4 feet of panel width, two minimum per panel.

Mounting: Evenly spaced along back-of-panel area.

Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted in Instrument List, Article SUPPLEMENTS.

Tag Function	**Inscription(s)**	**Color**
OO	ON	Red
	OFF	Green
OC	OPEN	Red
	CLOSE	Green
OCA	OPEN	Red
	CLOSE	Green
	AUTO	White
OOA	ON	Red
	OFF	Green
	AUTO	White
MA	MANUAL	Yellow
	AUTO	White
SS	START	Red
	STOP	Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red
Unused or Noninscribed Buttons		Black.

Standard Light Colors and Inscriptions: The following table gives the inscriptions for service legends, and the lens colors for indicating lights.

Tag Function	**Inscription**	**Color**
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

Lettering Color:

Black on white and amber lenses.
White on red and green lenses.

FABRICATION:

General

Panels with external dimensions and instruments arrangement as shown on Drawings.

Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.

Fabricate panels, install instruments, wire, and plumb, at the PICS factory.

Electrical Work: In accordance with Division 16, ELECTRICAL.

Shop Assembly: No panel assembly other than correction of minor defects or minor transit damage shall be done on panels at site.

UL Label for Enclosures: UL label stating “Listed Enclosed Industrial Control Panel.”

Wiring Within PICS Panels:

Routed through slotted PVC wiring duct with mating cover.

Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

Arrange wiring neatly, cut to proper length, and remove surplus wire.
Abrasion protection for wire bundles, which pass through holes or across edges of sheet metal.

Connections to Screw Type Terminals:

Locking-fork-tongue or ring-tongue lugs.

Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations and to avoid crossovers at a 90 degree angle.

Wires terminated in a crimp lug, maximum of one.

Lugs installed on a screw terminal, maximum of two.

Connections to Compression Clamp Type Terminals:

Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.

Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two, or quantity as approved by manufacturer.

Splicing and tapping of wires, allowed only at device terminals or terminal blocks.

Terminate 24V dc and analog terminal blocks separate from 120V ac circuit terminal blocks.

Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.

Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

Temperature Control:

Freestanding Panels:

Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.

Ventilated Panels:

Provide all ventilated panels with louvers and fans with filters or other cooling means as required to maintain internal temperature between 40 degrees F to 90 degrees F.

For panels with backs against wall, furnish louvers on top and bottom of panel sides.

For panels without backs against wall, furnish louvers on top and bottom of panel back.

Louver Construction: Stamped sheet metal.

Ventilation Fans:

Furnish where required to provide adequate cooling.
Create positive internal pressure within panel.

Fan Motor Power: 120 volts, 60-Hz ac, thermostatically controlled.

Air Filters: Washable aluminum, Hoffman Series A-FLT.

Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.

Freestanding Panel Construction:

Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 12-gauge, unless otherwise noted.

Panel Fronts:

Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
No seams or bolt heads visible when viewed from front.

Panel Cutouts: Smoothly finished with rounded edges.

Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

Internal Framework:

Structural steel for instrument support and panel bracing.
Permit panel lifting without racking or distortion.
Lifting rings to allow simple, safe rigging and lifting of panel during installation.

Adjacent Panels: Securely bolted together so front faces are parallel.

Doors: Full height, fully gasketed access doors where shown on Drawings.

Latches: Three-point, Southco Type 44.

Handles: “D” ring, foldable type.

Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.

Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.

Front and Side Access Doors: As shown on Drawings.

Nonfreestanding Panel Construction:

Based on environmental design requirements required and referenced in Article ENVIRONMENTAL REQUIREMENTS, provide the following:

For panels listed as inside:

Enclosure Type: NEMA 12 in accordance with NEMA 250.

Materials: Steel.

For all other panels:

Enclosure Type: NEMA 4X in accordance with NEMA 250.

Materials: Type 316 stainless steel.

Metal Thickness: 14-gauge, minimum.

Doors:

Rubber-gasketed with continuous hinge.
Stainless steel lockable quick-release clamps.

Manufacturers:

Hoffman Engineering Co.
H. F. Cox.

Factory Finishing:

Enclosures:

Stainless Steel and Aluminum: Not painted.

Nonmetallic Panels: Not painted.

Steel Panels:

Sand panel and remove mill scale, rust, grease, and oil.
Fill imperfections and sand smooth.
Prepare metal and paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
Sand surfaces lightly between coats.

Dry Film Thickness: 3 mils, minimum.

Color: Light gray.

Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

CORROSION PROTECTION:

Corrosion-Inhibiting Vapor Capsule Manufacturers:

Northern Instruments; Model Zerust VC.
Hoffmann Engineering Co; Model A-HCI.

SOURCE QUALITY CONTROL:

Factory Demonstration Testing (FDT):

Scope: Test PICS control panels to demonstrate panel assemblies are operational, prior to shipment:

Location: PICS factory.

Loop-Specific Functions: Demonstrate proper functions for each control loop, as shown on P&IDs and as required.

Make following documentation available to Construction Manager both before and after FDT:
Master copy of FDT procedures.
List of equipment to be tested including make, model, and serial number.
Equipment and loop verification sheets signed by PICS Construction Subcontractor showing that each equipment and loop has been tested and has functioned properly.

PART 3 – EXECUTION

EXAMINATION:

For equipment not provided by PICS, but that directly interfaces with the PICS, verify the following conditions:

Proper installation.
Calibration and adjustment of positioners and I/P transducers.
Correct control action.
Switch settings and dead bands.
Opening and closing speeds and travel stops.
Input and output signals.
Report discrepancies to the Construction Manager.

INSTALLATION:

Material and Equipment Installation: Retain a copy of manufacturers' instructions at site, available for review at all times.

Electrical Wiring: As specified in Division 16, ELECTRICAL

Removal or Relocation of Materials and Equipment:

Remove from site materials that were part of the existing facility but are no longer used, unless otherwise directed by Construction Subcontractor to deliver to Construction General Contractor.

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

CONSTRUCTION QUALITY CONTROL

Testing:

Onsite testing shall be required for each major process instrumentation and control system in accordance with this section and submitted/accepted test procedures. Provide personnel and equipment in support of PICS Continuity (PCT) and PICS Functionality (PFT) testing.

Tests shall be performed to demonstrate that each function is implemented and operational. These tests are electrical component tests to be performed in advance of facility-wide construction acceptance testing

(CAT). CAT shall be performed in accordance with Division 1 requirements. Copies of all tests shall be submitted as specified herein.

Startup and Testing Team:

Thoroughly inspect installation, termination, and adjustment for components and systems.
Complete onsite tests.
Complete onsite training.
Provide startup assistance.

PICS Continuity Test (PCT) Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PICS is ready for operation.

Loop/Component Inspections and Calibrations:

Check PICS for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.

Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).

Project name.

Loop number.

Component tag number.

Component code number.

Manufacturer for elements.

Model number/serial number.

Summary of functional requirements, for example:

Indicators and recorders, scale and chart ranges.

Transmitters/converters, input and output ranges.

Computing elements' function.

Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).

Calibrations, for example:

Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.

Discrete Devices: Actual trip points and reset points.

Space for comments.

These inspections and calibrations will be witnessed by the Construction Manager or designated representative(s).

PICS Functionality Test (PFT):

General:

Test all PICS elements to demonstrate that PICS satisfies all requirements.

Test Format: Cause and effect.

Person conducting test initiates an input (cause).
Specific test requirement is satisfied if correct result (effect) occurs.

Procedures, Forms, and Checklists:

Conduct tests in accordance with, and documented on, Tank Farm Contractor accepted procedures, forms, and checklists.

Describe each test item to be performed.

Have space after each test item description for sign off by appropriate party after satisfactory completion.

Required Test Documentation: Test procedures, forms, and checklists. All signed by Construction Manager and Construction General Contractor.

Conducting Tests:

Provide special testing materials, equipment, and software.

Wherever possible, perform tests using actual process variables, equipment, and data.

If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.

Define simulation techniques in test procedures.

Coordinate PICS testing with Construction Manager and affected Construction Subcontractors.

Test Requirements:

Once facility has been started up and is operating, perform a witnessed PFT on complete PICS to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.

Perform local and manual tests for each loop before proceeding to remote and automatic modes.

Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

Make updated versions of documentation required for PFT available to Construction Manager at site, both before and during tests.

Make one copy of O&M manuals available to Construction Manager at the site both before and during testing.

TRAINING:

General:

Provide an integrated training program to meet specific needs of Tank Farm Contractor's personnel in accordance with submitted and accepted training plan.

Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

Provide instruction on two working shifts as needed to accommodate the Tank Farm Contractor's personnel schedule.

Tank Farm Contractor reserves the right to make and reuse video tapes of training sessions.

Provide reference handouts that cover the course content for all personnel attending any course or training session.

Operations and Maintenance Training:

Include a review of O&M manuals and survey of spares, expendables, and test equipment.

Use equipment similar to that provided or currently owned by Tank Farm Contractor.

Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

Operations Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: Two.

Location: Site.

Content: Conduct training on loop-by-loop basis.

Loop Functions: Understanding of loop functions, including interlocks for each loop.

Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.

Interfaces with other control systems.

Maintenance Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: One.

Location: Project site.

Content: Provide training for each type of component and function provided.

Loop Functions: Understanding details of each loop and how they function.

Component calibration.

Adjustments: For example, controller tuning constants, current switch trip points, and similar items.

Troubleshooting and diagnosis for components.
Replacing lamps, fuses.
Component removal and replacement.
Periodic maintenance.

CLEANING/ADJUSTING:

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

Cleaning:

Prior to closing system using tubing, clear tubing of interior moisture and debris.
Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

PROTECTION:

Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

SUPPLEMENTS:

Supplements listed below, following "END OF SECTION," are part of this Specification.
Supplement 1—Instrument Listing for Cell No. 1 and Cell No. 2.
Supplement 2—Component Specifications.
Supplement 3—PLC Input and Output List.
Supplement 4—Loop Specifications.
Supplement 5—PLC and OIU Application Software Setpoints for Cells No. 1 and No. 2.

END OF SECTION 13401

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
1	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 1	48"W x 20"D x 72"High NEMA 12
2	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Operator Interface Unit	H-2-830855	Y50	NA			Ethernet Communication
20	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Main and Sub Breakers	H-2-830855	Reference 13401 PICS	NA			
21	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	High Density Breakers	H-2-830855	Reference 13401 PICS	NA			
22	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Surge Protection	H-2-830855	Reference 13401 PICS	NA			
23	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	24 V dc Power Supplies	H-2-830855	Reference 13401 PICS	NA			Size power supplies for all control loops and various local control panel power
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC, I/O, Power Supply and Chassis	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC Programming and Communication Software	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Laptop	H-2-830855	Y50	NA			
25	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Ethernet Switch and Mounting Bracket	H-2-830855	Y50	NA			
26	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Duct	H-2-830855	Reference 13401 PICS	NA			
27	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Analog	H-2-830855	Reference 13401 PICS	NA			
28	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Interposing Relays	H-2-830855	Reference 13401 PICS	NA			
29	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Discrete and Power	H-2-830855	Reference 13401 PICS	NA			
3	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Locking Mechanism	H-2-830855	Reference 13401 PICS	NA			
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Cooling Fan	H-2-830855	Reference 13401 PICS	NA			
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Temperature Thermostat	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	
31	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Receptacle	H-2-830855	Reference 13401 PICS	NA			

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
32	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Uninterruptible Power Supply	H-2-830855	Y40	NA		Reference Controls on Dwg. H-2-830857 sheet 2	1050 VA, 120V in - 120V out The UPS system has been disconnected and removed and may be reinstalled in the future.
33	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Incandescent Lighting	H-2-830855	Reference 13401 PICS	NA			
34	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Signal Isolators	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	
96	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Alarm Dialer	H-2-830855	Y51	NA	NA		
97	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Cellular Modem (CDMA)	H-2-830855	Y52	NA	NA		
40	1	219(Y)	LH	LCP	002	Crest Pad Building Sump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
41	1	219(Y)	LH	LCP	003	Combined Sump Instrinsic Safety Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
68	1	219(Y)201	LH	LCP	004	Leachate Storage Tank Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
42	1	219(Y)1	LH	LCP	005	Leachate Transfer Pump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
91	1	219(Y)	LH	LCP	208	Secondary Leachate Collection System Local Control Panel	Enclosure	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA	NA	H-2-830849 sheet 2 of 2	16" W x 18" H x 9" D NEMA 4X - fiberglass reinforced polyester, with Data logger, input/output channel, signal converter, communications, rechargeable battery, and charge controller
95	1	219(Y)	LH	LED	208	Secondary Leachate Collection System Local Control Panel	Loop Powered Process Indicator	H-2-830854 sheet 1 of 4		NA	NA	H-2-830849 sheet 2 of 2	Red Lion, Model CUB4LP
4	1	219(Y)	LH	LI	101	Leachate Collection and Removal System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		
43	1	219(Y)	LH	LT	101	Leachate Collection and Removal System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX)
5	1	219(Y)	LH	LI	104	Leak Detection System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
44	1	219(Y)	LH	LT	104	Leak Detection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	-	Sensor supplied with termination enclosure (TBX) under this section and installed by pump vendor
45	1	219(Y)	LH	HS	105	Crest Pad Building Sump Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 1 of 4	M12	NA	On/ Off		Bypass Operation
46	1	219(Y)	LH	LDE	105	Crest Pad Building Sump	Leak Detection Sensor	H-2-830854 sheet 1 of 4	L109	Actuate elevation 720.5	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
47	1	219(Y)	LH	LSH	105	Crest Pad Building Sump High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 722.0	Feet	Detail No. 1 on Dwg. H-2-830854	
48	1	219(Y)	LH	LSHH	105	Crest Pad Building Sump High High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 723.0	Feet	Detail No. 1 on Dwg. H-2-830854	
49	1	219(Y)	LH	LSL	105	Crest Pad Building Sump Low	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 721.0	Feet	Detail No. 1 on Dwg. H-2-830854	
50	1	219(Y)	LH	HS	107	Combined Sump Instrinsic Safety Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Bypass Operation
51	1	219(Y)	LH	LDE	107	Combined Sump Pump	Leak Detection Sensor	H-2-830854 sheet 2 of 4	L109	Actuate elevation 714.2	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
52	1	219(Y)	LH	LSH	107	Combined Sump High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 718.0	Feet	Detail No. 1 on Dwg. H-2-830854	
53	1	219(Y)	LH	LSHH	107	Combined Sump High High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 719.0	Feet	Detail No. 1 on Dwg. H-2-830854	
54	1	219(Y)	LH	LSL	107	Combined Sump Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 717.0	Feet	Detail No. 1 on Dwg. H-2-830854	
55	1	219(Y)	LH	LSLL	107	Combined Sump Low Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 715.0	Feet	Detail No. 1 on Dwg. H-2-830854	
92	1	219(Y)	LH	LT	108	Secondary Leachate Collection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830856	Signal interface shall be 12V dc supply instead of 24V dc
94	1	219(Y)	LH	FE	208	Secondary Leachate Collection System	Flow Meter	H-2-830854 sheet 1 of 4		1 to 20	GPM		Battery powered flow meter (Omega FTB 790 Series or approved equal).
7	1	219(Y)	LH	FI	202	Leachate Collection and Removal System Low Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 25	GPM		0-30 PSI Range

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
56	1	219(Y)	LH	FIT	202	Leachate Collection and Removal System Low Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 25	GPM	Section A on Dwg. H-2-830847	0-30 PSI Range with integral transmitter
57	1	219(Y)	LH	HS	202	Leachate Collection and Removal System Low Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
84	1	219(Y)	LH	PI	202	Leachate Collection and Removal System Low Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 30	PSI		0-30 PSI Range with Diaphragm Seal
58	1	219(Y)	LH	YL	202	Leachate Collection and Removal System Low Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
8	1	219(Y)	LH	FI	203	Leachate Collection and Removal System High Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 250	GPM		0-60 PSI Range
59	1	219(Y)	LH	FIT	203	Leachate Collection and Removal System High Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 250	GPM	Section A on Dwg. H-2-830847	0-60 PSI Range with integral transmitter
60	1	219(Y)	LH	HS	203	Leachate Collection and Removal System High Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
85	1	219(Y)	LH	PI	203	Leachate Collection and Removal System High Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 60	PSI		0-60 PSI Range with Diaphragm Seal
61	1	219(Y)	LH	YL	203	Leachate Collection and Removal System High Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
9	1	219(Y)	LH	FI	204	Leak Detection System Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 15	GPM		0-15 PSI Range
62	1	219(Y)	LH	FIT	204	Leak Detection System Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 15	GPM	Section A on Dwg. H-2-830847	0-15 PSI Range with integral transmitter
63	1	219(Y)	LH	HS	204	Leak Detection System Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
86	1	219(Y)	LH	PI	204	Leak Detection System Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
64	1	219(Y)	LH	YL	204	Leak Detection System Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
65	1	219(Y)	LH	HS	205	Crest Pad Building Sump Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
89	1	219(Y)	LH	PI	205	Crest Pad Building Sump Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
66	1	219(Y)	LH	YL	205	Crest Pad Building Sump Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
93	1	219(Y)	LH	DPI	206	Crest Pad Building	Wall-Mounted Differential Pressure Indicator	H-2-830854 sheet 1 of 4	Reference 15100 (LEACHATE	0 TO 15	PSID		With re-settable drag pointer

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number FILTERS)	Process Ranges	Eng. Units	Detail	Comments
67	1	219(Y)	LH	HS	207	Combined Sump Pump	Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
69	1	219(Y)	LH	YL	207	Combined Sump Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
12	1	219(Y)	LH	HS	219	Crest Pad Building	Control Panel Mount Switch	H-2-830854 sheet 1 of 4	M12	NA			Alarm Acknowledge Switch
70	1	219(Y)	LH	JSH	219	Crest Pad Building	Power Relay	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA			Power Relay mounted inside Control Panel
10	1	219(Y)	LH	TI	219	Crest Pad Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 104	˚F		
71	1	219(Y)	LH	TIT	219	Crest Pad Building	Temperature Transmitter	H-2-830854 sheet 1 of 4	T3	-40 to 104	˚F		With integral transmitter
72	1	219(Y)	LH	YAL	219	Crest Pad Building	Alarm Light	H-2-830854 sheet 1 of 4	M31	NA			
11	1	219(Y)1	LH	TI	220	Leachate Transfer Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 104	˚F		
73	1	219(Y)1	LH	TIT	220	Leachate Transfer Building	Temperature Transmitter	H-2-830854 sheet 2 of 4	T3	-40 to 104	˚F		With integral transmitter
74	1	219(Y)1	LH	YAL	220	Leachate Transfer Building	Alarm Light	H-2-830854 sheet 2 of 4	M31	NA			
88	1	219(Y)201	LH	HS	301	Leachate Storage Tank Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Bypass Operation
75	1	219(Y)201	LH	LSHH	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 728.33	Feet	Detail No. 2 on Dwg. H-2-830854	
76	1	219(Y)201	LH	LSLL	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 722.7	Feet	Detail No. 2 on Dwg. H-2-830854	
77	1	219(Y)201	LH	LT	301	Leachate Storage Tank	Submersible Pressure Transducer	H-2-830854 sheet 2 of 4	L42	0 to 108	Inches	Detail No. 3 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX) and Lightning Arrestor
78	1	219(Y)201	LH	LI	301-1	Leachate Storage Tank	Local Control Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator, and Lightning Arrestor
6	1	219(Y)201	LH	LI	301-2	Leachate Storage Tank	Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator
79	1	219(Y)1	LH	HS	302	Leachate Transfer Pump	Panel Mount Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/ Off		Motor On/Off control switch
87	1	219(Y)1	LH	PI	302	Leachate Transfer Pump	Pressure Gauge (Load)	H-2-830854 sheet 2 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
90	1	219(Y)1	LH	PI	303	Leachate Transfer Pump	Pressure Gauge (Suction)	H-2-830854 sheet 2 of 4	P4/P6	0 to 100	Inches		0-100 Inches Range with Diaphragm Seal
80	1	219(Y)1	LH	FIT/FQ I	302-1	Leachate Transfer Pump	In-Line Flow Magmeter	H-2-830854 sheet 2 of 4	F4	0 to 300	GPM	Section A on Dwg. H-2-830851	0-15 PSI Range. Flow and Total Integral with same indicator.

Instrument Listing for Cell No. 1 & Cell No. 2

Instrument Listing Sorted by Equipment Nu

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 3 ISA	Tag 4 Eqt.#	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
81	1	219(Y)1	LH	YL	302-1	Leachate Transfer Pump	Local Control Panel Mount Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			
82	1	219(Y)1	LH	FQI	302-2	Leachate Transfer Pump	Local Control Panel Mount Flow Totalizer Indicator	H-2-830854 sheet 2 of 4	S27	0 to 10,000	Gal		Flow and Total Integral to same meter. Provided Signal Isolator
83	1	219(Y)1	LH	YL	302-2	Leachate Transfer Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440

(Y) = A for Cell No. 1
(Y) = E for Cell No. 2

For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.
For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.

Component Specifications:

F4 Flow Element and Transmitter, Electromagnetic:

General:

Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

Type:

Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.

Full bore meter with magnetic field traversing entire flow-tube cross section.

Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.

Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

Service:

Stream Fluid:

As noted.

Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.

Flow Stream Descriptions: If and as described below.

Operating Temperature:

Element:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Transmitter:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Storage: 15 to 120 degrees F, typical, unless otherwise noted.

Performance:

Flow Range: As noted.

Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 33 feet per second.

Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

Features:

Zero stability feature to eliminate the need to stop flow to check zero alignment.

No obstructions to flow.

Very low pressure loss.

Measures bi-directional flow.

Process Connection:

Meter Size (diameter inches): As noted.

Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.

Flange Material: Carbon steel, unless otherwise noted.

Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

Element:

Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.

Liner Material:

Teflon, unless otherwise noted.

Low activated waste leachate solution.

Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.

Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.

Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.

Grounding Ring:

Required, unless otherwise noted.

Material: Type 316 stainless steel, unless otherwise noted.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Transmitter:

Mounting: Integral, unless otherwise noted.

Display: Required, unless otherwise noted.

Digital LCD display, indicating flow rate and total.

Bi-directional Flow Display: Required, unless otherwise noted.

Forward flow rate.
Forward, net totalization.
Parameter Adjustments: By keypad or non-intrusive means.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Empty Pipe Detection: Drives display and outputs to zero when empty pipe

Signal Interface (at Transmitter):

Analog Output:

Isolated 4 to 20 mA dc for load impedance from 0 to at least 500 ohms minimum for 24V dc supply.
Supports Superimposed Digital HART protocol.
Cables:

Types: As recommended by manufacturer.

Lengths: As required to accommodate device locations.

Built-in Diagnostic System:

Features:

Field programmable electronics.
Self-diagnostics with troubleshooting codes.

Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.

Initial flow tube calibration and subsequent calibration checks.

Factory Calibration:

Calibrated in an ISO 9001 and NIST certified factory.
Factory flow calibration system must be certified by volume or weight certified calibration devices.

Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

Factory Ready for Future In situ Verifications: If noted.

Original meter parameter values available from vendor by request.

Accessories:

In situ Verification System: If noted.

Quantity: One complete system provided for the project.

Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.

Physical access to the flow-tube not required.

Meet standards established by the National Testing Laboratory.

Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.

Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.

Windows-based software

Primary Simulation System: If noted.

Quantity: One complete system provided for the project.

Verifies proper operation of the signal converter by simulating the flow meter's output signal.
Generates pulsed dc excitation signal with a reference voltage of 70 mV.
Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.
Switch selectable for forward, reverse and zero flow rate.
Verifies various input and output signals.

Manufacturers:

Krohne Electromagnetic Integral Systems: Aqua Flux Flowmeter (size: 3/8 to 120 inches).

Endress & Hauser, Inc. Flow Measuring System: Promag 50/53W (size: 1 to 78 inches).

Invensys Foxboro (includes IMT 25 Series Intelligent Magnetic Flow Transmitter): 9100A Series Flanged Body Flow Tubes (size: 1 to 78 inches).

L1A Multipoint Level Element and Switches, Admittance:

General:

Function: Operate switches at two separate, distinct, preset product levels in a vessel.

Type: Admittance using low power radio frequency circuit.

Parts: Element and electronics unit. For remote mount, interconnecting cable.

Service: Fluid as noted.

Performance:

Set Points: As noted.

Temperature: Operating range minus 40 to 140 degrees F.

Unaffected by coating buildup on element.

Features:

Electronics Unit:

Filtering: Built-in RFI protection.

Fail-Safe Contacts: Field convertible switch action.

Enclosure Type: Explosion-proof and weatherproof (NEMA 4).

Electronics Mounting: Integrally with element, unless otherwise noted.

When remote, provide cable with length as required to accommodate device locations.

Response Time: 20 milli-seconds standard, or as noted.

Element:

Type: Probe rod.

Insertion Length: As required to achieve noted set points.

Material: 316 stainless steel, unless otherwise noted.

Rating: Element and cable intrinsically safe.

Grounding Element: Required for nonmetallic tank applications.

Process Connection: 3/4-inch NPT unless otherwise noted.

Signal Interface: Contacts, 3 DPDT rated 5A continuous at 120V ac, minimum.

Power: 120V ac 50/60-Hz, or as noted.

Manufacturers and Products:

Drexelbrook; Model 506-3100.
Princo.
Endress & Hauser, Inc.

L8 Level Switch, Float:

General:

Function: Actuate contact at preset liquid level.

Type: Direct-acting float with an enclosed mercury switch and integral cable.

Service: Liquid; low activated waste leachate solution, unless otherwise noted.

Performance:

Set Point: As noted.

Differential: 1-inch maximum.

Temperature: 0 to 180 degrees F.

Features:

Entire Assembly: Watertight and impact-resistant.

Float Material and Size: Polyethylene/foam filled; 4.5-inch diameter tear drop.

Cable:

Combination support and signal.
Length as noted or as necessary per mounting requirements.
Type SO nitrile PVC jacket, AWG No. 18/2 or No. 18/4.

Mounting:

Pipe:

Cable-to-pipe clamp, corrosion-proof cable for 1-inch pipe.
Pipe-to-wall bracket for 1-inch pipe.

Suspended Type: As noted.

Signal Interface:

Switch Type: Mercury tilt.

Switch Contacts:

Isolated, rated 4.5A continuous at 120V ac.
As required (for example 1NO, 1NO+1NC) to meet functional requirements, or as shown.

Manufacturers and Products:

Consolidated Electric Co.; Model LS.
Anchor Scientific; Roto-Float, Type P/Type S.

L42 Level Element/Transmitter, Submersible, Wastewater:

General:

Function: Measure and transmit a signal proportional to level.

Type: Totally submersible pressure sensor (loop powered).

Parts: Sensor, interconnecting cable, sensor termination enclosure.

Service:

Fluid: Wastewater, unless otherwise noted.

Performance:

Process Range:

As noted.
Provide fixed factory range such that noted process range is between 40 and 80 percent of fixed factory range.

Accuracy: 0.25 percent of full scale.

Temperature, Operating: Minus 4 to plus 140 degrees F.

Overpressure: Range dependent.

4X for ranges of 5 psig and above (to a maximum of 2,000 psi).
Greater than 4X for ranges below 5 psig.

Long Term Stability: Plus or minus 0.1 percent full scale/year, typical.

Features:

Sensor:

Silicon sensing element.
Titanium body.

Diaphragm: Titanium isolation, unless otherwise noted.

Pressure Connection: Depth cone with radial inlet holes.

NEMA 6 rating (submersible to 2,300 feet).

Temperature Compensation: Plus 30 to 80 degrees F.

Dimensions: Not to exceed 8.5L by 1.1 diameter, inches, nominal.

Loop powered, 9-30V dc.
Open face with perforated Protective Plate: Not to exceed 1.35 diameter, inches.

Interconnecting Cable:

Length: As required.

Polyurethane sheathed.
Kevlar strain relief cord.
Integral vent tube.

Sensor Termination Enclosure:

Enclosure: NEMA 4X, PVC/polycarbonate.

Desiccant module.
Micro filter.

Wall and 2-Inch Pipe Mounting Kit: Required, unless otherwise noted.

Lightning Arrestor(s): Required, unless otherwise noted.

Signal Interface: 4 to 20 Ma dc output, for load impedance of 0 to 750 ohms, minimum for 24V dc supply without load adjustment.

Area Classification: Intrinsically safe; certified for use in Class 1, Division 1, Groups A, B, C, and D atmospheres.

Manufacturers:

Druck; Type PTX 1830 with STE110.
Pressure Systems, Inc. KPSI; Series 720 with Series 815 Aneroid Bellows and Series 840 Junction Box.
Or approved equivalent.

L109 Level Detection Switch, Rises on Stem:

General:

Function: Actuate contact at preset liquid level.

Type: Direct acting; rises on stem.

Service: Liquid, water, wastewater, unless otherwise noted.

Performance:

Set point as noted.

Switch Actuation Point: Approximately 3/4-inch distance from end of stem to weighted support collar.

Operating Temperature Range: Minus 40 to plus 110 degrees F.

Features:

Assembly Material: Brass stem, Buna N Float, and Type 316 stainless steel wetted parts.

Float Size: 2-inch diameter.

Mounting: Suspension cable with compact-sized float, slosh shield, and weighted collar suspended in standpipes or sumps for leak detection.

Signal Interface:

Switch Type: Magnetic reed switch.

Switch Contacts:

SPST Isolated, rated at 20 VA.
NC (by inverting float on unit stem).

Cable and Lead Wires: No. 22 AWG, 25 feet of length of PVC jacketed cable.

Manufacturer and Product: GEMS; Specialty Switches Liquid Level Switch, Model LS-750.

M12 Hand Switch and Light, Oiltight, Round:

General:

Function: Select, initiate, and display discrete control functions.

Type: Heavy-duty, oiltight, industrial.

General Features:

Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.

Legend Plate: Standard size square style aluminum field and black markings, unless otherwise noted. Markings as shown.

Configuration: Light, pushbutton, or switch as noted or shown.

Light Features:

Lights: 6V ac lamps and integral transformer for operation from 120V ac, unless otherwise noted.

Lens Color: Color as specified under PANEL, STANDARD LIGHT COLOR AND INSCRIPTIONS, or as noted.

Pushbutton and Switch Features:

Guard: Full guard with flush button, unless otherwise noted.

Operator: Black pushbutton, black non-illuminated knob on switch, unless otherwise noted.

Boot: None, unless otherwise noted.

Signal Interface:

Contact Block:

Type: Silver-coated butting, unless otherwise noted.

Rating: 10 amps continuous at 120V ac or as noted.

Sequence: Break-before-make, unless otherwise shown.

Arrangement: Normally open or normally closed as shown, or perform functions noted.

Terminals: Screw with strap clamp, unless otherwise noted.

NEMA Rating: NEMA 4, watertight and dusttight and NEMA 13, oiltight.

Manufacturers/Models:

Allen-Bradley; Bulletin 800T.
Eaton Corp.; Cutler-Hammer, Type 10250T.
Square D Co.; Class 9001, Type K.

M31 Warning Light, Indoor/Outdoor:

General:

Function: Visual alarm.

Type: Rotating reflector or flashing bulb.

Parts: Light and spare bulbs.

Performance:

Temperature, Operating: Minus 35 to 190 degrees F.

Flash Rate: Nominally 90 per minute.

Features:

Dome Color: Amber, unless otherwise noted.

Lamp Life: 200 hours.

Lamp: Incandescent/25 watts.

Enclosure:

Type: Water-resistant closed cell neoprene gasket.

Mounting: Wall bracket, unless otherwise noted.

UL Listing: Indoor/outdoor use.

Power: 120V ac, 50/60-Hz.

Spare Bulbs: Two for each light.

Manufacturers:

Federal Signal; Model 225.
Benjamin Electric Manufacturing; Series KL-4000.

P4 Pressure Gauge:

General:

Function: Pressure indication.

Type: Bourdon tube or bellows.

Performance:

Scale Range: As noted.

Accuracy: Plus or minus 0.50 percent of full scale for Bourdon tube. Plus or minus 2-1-2% of span (ASME B 40.1 Grade A).

Features:

Liquid Filled: Required unless otherwise noted.
Glycerin fill, unless otherwise noted.

Dial: 4-1/2-inch diameter, unless otherwise noted.

Case Material: Black phenolic plastic, unless otherwise noted.

Element Material: Phosphor-bronze, unless otherwise noted.

Pointer: Micrometer-adjustable.

Movement: Stainless steel, Teflon coated bearings, rotary geared.

Window: Glass, unless otherwise noted.

Socket Materials: brass, unless otherwise noted.

Threaded reinforced polypropylene front ring for easy zero adjustment.

Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.

Process Connection:

Mounting: Lower stem, unless otherwise noted.

Size: 1/2 inch, unless otherwise noted.

Connection Type: Threaded (NPT).

Manufacturers and Products:

Ashcroft; Duragauge Model 1279/1379.
Ashcroft LP Bellows Gauge Model 1188.
Weksler; Royal Process Gauge Model AAXX.
Ametek U.S. Gauge; Solfrunt Model 19XX.
P6 Pressure Seal, Diaphragm:

General:

Function: Isolate sensing element from process fluid.

Type: Fluid filled, corrosion resistant.

Service:

Pressure: Same as associated sensor.

Temperature: As noted.

Features:

Material Lower Housing: Type 316 stainless steel, unless otherwise noted.

Diaphragm Material: Type 316 stainless steel, unless otherwise noted. Bleed screw in upper housing.

Fill Fluid: As noted. Factory filled and assembled when possible.

Process Connections:

Instrument: 1/2-inch female NPT, unless otherwise noted.

Process: 1/2-inch female NPT, unless otherwise noted.

Connection Material: compatible with pressure indicator and process lines.

Manufacturers:

Ametek, Mansfield and Green Division; Type SG.
Ashcroft; Type 101.
Ashcroft; Type 741.

S27 Indicator, Digital Panel:

General:

Function: Display analog signal, or totalize analog signal, and display engineering units.

Type: 7-segment digital, horizontal edgewise.

Performance:

Range: As noted, engineering units as noted.

Accuracy: Plus or minus 0.1 percent full scale.

Temperature, Operating: 32 to 120 degrees F.

Features:

Digits: 4-1/2; 0.56-inch high minimum; 7-segment LED, gas plasma, or vacuum fluorescent.

Decimal Point: Field selectable.

Input Impedance: 100 ohms maximum.

Service Legend: Permanent, display of engineering units.

Response Time: 1 second maximum to 0.1 percent accuracy.

Signal Interface: 4 to 20 mA dc.

Enclosure:

Type: NEMA 4X.

Mounting: Panel; approximately 2-inch high, 4-inch wide, 5-inch deep.

Power: 120V ac, 50/60-Hz unless otherwise noted.

Manufacturers:

Red Lum Controls.

Action Instruments.
Analogic.
Moore Industries.

T3 Temperature Element and Transmitter, Resistance:

General:

Function: Measure the temperature of ambient, and transmit analog signal proportional to temperature.

Type: RTD.
Parts: Element and transmitter.

Service:

Process: As noted.

Process Temperature Range: As noted.

Element:

Type:

Single-element, unless otherwise noted
Three-wire, RTD.
Platinum, 100 ohm nominal at 0 degrees C.

Performance:

Accuracy: Greater of plus or minus 4 degrees F or plus or minus 0.75 percent of reading.

Features:

Dimensions: 1/4-inch diameter.
Length to accommodate thermowell insertion and extension lengths.
Spring-loaded element when well is used.

Sheath:

Type 316 Stainless Steel, unless otherwise noted.

Process Operating Temperature Range: Minus 320 to 900 degrees F, unless otherwise noted.

Terminal Connection Head:

General purpose, NEMA 4 weatherproof, unless otherwise noted.

Maximum Temperature: 220 degrees F, unless otherwise noted.

Thermowell Connection: Union Coupler, unless otherwise noted.

Sensitive Length: 1.6 inch minimum, measured from closed end.

Transmitter:

Ambient Operation Conditions.

Temperature: minus 40 to 140 degrees F, with display.

Relative Humidity: 0 to 100 percent, noncondensing.

Type: Two-wire, powered by a remote power supply.

Performance:

Accuracy: Greater of plus or minus 0.7 degree F or plus or minus 0.06 percent of span.

Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.

Electrical Safety: Standard unless otherwise noted.

Features:

Indicator: Three line LCD, unless otherwise noted.
Automatic reference junction compensation.

Failsafe Mode:

User configurable ON, unless otherwise noted.
Downscale, unless otherwise noted.

Electric Damping: 1.2 seconds.

Signal Interface: 4 to 20 mA dc

Power: 24V dc external power supply.

Digital Communication: HART.

One HART communicator to be supplied for all HART capable transmitters, if not already supplied under another Specification section.

Enclosure:

Materials: Epoxy coated, low-copper aluminum, unless otherwise noted.

Type: NEMA 4X.

Mounting: Wall, as noted.
For wall, provide stainless steel mounting set, unless otherwise noted.

Manufacturers and Products:

Foxboro; RTT20 Series Transmitter with PR Series RTD and Thermowell.
Rosemount; 78 Series Platinum RTD and Model 644H Transmitter.

Y40 Uninterruptible Power Supply System:

General:

Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.

Major Parts: Inverter, a battery charger, sealed battery.

Performance:

Capacity: As noted.

Input Power:

120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

Output Power:
120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

On-line Efficiency: 85 percent minimum, unless otherwise noted.

Backup Runtime:

Full Load: 9 minutes minimum, unless otherwise noted.

Half Load: 24 minutes minimum, unless otherwise noted.
Continuous no-break power with no measurable transfer time.

Sine-Wave Output Power Regulation:

Plus or minus 5 percent or less total harmonic distortion.
Meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.

Voltage Regulation: Plus or minus 3 percent nominal.

Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).

Lightning and Surge Protection:

Pass lightning standard ANSI/IEEE C62.41 Categories A and B test.
2000 to 1 attenuation of input spike.

Isolation:

True separately derived power source as per NEC Article 250-5d with output neutral bonded to ground.
Complete from line.
Less than 2 pF effective input to output capacitance.

Features:

Enclosure: Floor mounted cabinet, unless otherwise noted.

RS232 external interface with full-duplex output capable of:
Remote monitoring of meter functions and alarm conditions.
Remote diagnostic testing.
Remotely set point display and adjustment.

Manufacturers:

Best Power, FERRUPS Uninterruptible Power System.
Controlled Power.
American Power Conversion; Back-UPS Pro.

Y50 Programmable Logic Controller and Operator Interface Unit System:

General:

Function: Microprocessor based system configured, assembled, and programmed in order to implement the safe automatic control and measurement of process control equipment.

System incorporates programmable logic controllers, processors, power supplies, operator interface units, communication hardware, programming and development software, and cables, and programming laptop.

Programmable Logic Controller (PLC):

Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.

PLC Parts: Central processing unit (CPU), power supply, local input/output modules, local (chassis/rack) controllers, I/O terminals board and termination cable assemblies, and factory assembled programming laptop, ETHERNET and OIU communication interconnecting cables.

PLC Central Processing Unit (CPU) Specifications:

Type: Microprocessor, 16-bit minimum.

Memory: 32K words.

I/O Capacity: 4096 inputs, 4096 outputs.
Standard RAM with lithium battery for 2 years backup.

Scan Time: 0.9 ms/1K ladder logic.

Communications:

Two communication ports, RS-232/RS485 and 10BASE-T Ethernet channel.
10 Mbps communications – TCP/IP protocol.
RS-232 and DH-485 Communication protocols.

Instruction Set:

Timers and Counters.

Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, exponent, and compare.

Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.

Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants.

Real Time Clock: Date and time set and compare.

Miscellaneous: Jump or skip to a label, one shot, quantity drums, pre-configured analog alarm functions, subroutines, quantity.

Environment:

Operating Temperature: 0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degree C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 15 Watts.

Agency Approvals and Standards:

UL listed.
CSA certified.
or another state approved agency.
Random Access Memory (RAM):

Type: CMOS type.

Word Size: 16 bits, minimum.

Battery Backup: 24 months, minimum.

Memory Size: Sufficient to implement all applications software plus 50 percent spare.

Read only memory (ROM) for controller's operating system and diagnostics.

Memory Protection: Keylock switch.

Manufacture and Product: Allen-Bradley 1747-L552.

PLC Power Supply: One unit for each input/output base assembly.

Voltage: 120/220 volts (user selectable), 60 Hz input; 24 VDC output.

Mounting: Integral with PLC chassis.

Manufacture and Product: Allen-Bradley 1747-P4.

PLC Input/Output: Complete input/output system specifications:

Discrete Input Modules:

Voltage: 24 VDC.

Operating Power: 2 watts.

Points per Module: 16 maximum.

LED status indicator for each point.
Isolation: Between input point and PLC, 1,500 volts rms.
Discrete Output Modules:

Voltage: 24VDC.

Operating Power: 2 watts.

Load Rating: 2 amps continuous.

Isolation: Between PLC and output point, 1,500 volts rms.

Points per Module: 16 maximum.

LED status indicator for each point.

Isolated Discrete Output Modules:

Type: Isolated Form C relay.

Voltage: 120 volts, 60-Hz.

Isolated Outputs per Module: 8 Maximum.

Load Rating: 2 amps continuous.

Operating Power: 2.5 watts.

LED status indicator and fuse for each point.

Analog Input and Output Modules:

Voltage: 24 volts dc.

Power: 3 watts.

Differential Analog Points Per Module: 8 maximum.

Isolated Analog Output Points Per Module: 8 maximum.

Isolation: Between PLC and I/O point and between I/O points, 1,500 volts rms.

Analog Input Resolution: 12 bits minimum.

Analog Output Resolution: 12 bits minimum .

Manufacturer and Series: Allen-Bradley 1746 Series.

Operator Interface Unit:

Function: Panel mounted terminal unit with color video display screen and keypad, which enable an operator to monitor and interface with the process control system programmable logic controller. OIU linked with PLC over ETHERNET network.

Type: Microprocessor based device and programmable using Microsoft Windows based development software. *(Note: PICS PLC and OIU design is based upon the Allen-Bradley SLC-5/05E programmable logic controller and the Allen-Bradley Panelview 600 operator interface unit).*

Parts: Central processing unit (CPU), power supply, video display touch screen, keypad, Ethernet and printer ports.

Specifications:

Electrical: DC Power Supply Limits: 85 to 264 VAC AC Power, Power Consumption 60 VA maximum.

Mechanical: Enclosure NEMA Type 12/13, 4X (Indoor use only), LED Indicators – "Green" COMM, "Red" FAULT.

Display: Active Matrix Thin Film resistor (TFT) with cold cathode fluorescent (CCF) backlight.

Size: 4.54 x 3.4 in.

Pixels: 320 x 234.

Touch Cells: 128 (16 columns x 8 rows).

Touch Cell Size: (20 x 29 pixels).

Terminal Memory: total application flash memory 240K bytes (application screens)

Environment:

Operating Temperature: -0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degrees C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 32 Watts.

Agency Approvals and Standards: UL, CSA certified, or another state approved agency.

Manufacturer and Model: Panelview600 or equal.

Software Packages:

PLC Programming: Microsoft Windows based RSLogix500 programming and communication software (RSLinx) with master disk, most recent revisions, and 2-year support.

OIU Programming: Microsoft Windows based Panelbuilder32 development software with master disk, most recent revisions, and 2-year support.

Ethernet Switch:

Function: Mixed Media 10/100 Base T 8 port modular fiber switch with 4 port fiber module and 4 port RJ45 dual speed module.

Specifications:

Address Table 24K nodes with address aging.

Cooling Method: Internal 9-CFM fan.

Filtering and Forwarding Rate: 16-port aggregate, 2380K packets per second.

Latency, 100 Mbps: 5 µs + packet time; 10 Mbps: 15 µs + packet time, Packet Buffers 8 MB dynamic.

Processing Type: Store and forward with IEEE 802.3x full-duplex flow control

Standards: IEEE 802.3: 10BASE-T, 10BASE-FL; IEEE 802.3u: 100BASE-TX, 100BASE-FX.

Connectors:

LE1401A, (1) power.
LE1419C: (4) pairs of SC.
LE1425C: (4) RJ-45.
Indicators Chassis: Power; Per port: LK: ON when link is operational; Act: ON with port activity; FDX/HDX: ON for full-duplex mode, OFF for half-duplex mode; 100/10: ON for 100 Mbps, OFF for 10 Mbps

Power Input: 110–240 VAC, 47–63 Hz, internal, autosensing; 20 W.

Size: 1.75 inches high (1U) by 17 inches wide by 9 inches deep (4.4 x 43.2 x 22.9 cm); weight: 2.5 pounds (1.1 kg).

Agency Approvals and Standards: UL, CSA or another state approved agency.

Manufacturer and Product: Black Box LE1401A; or equal.

Programming Notebook (Laptop) Computer:

Function: Notebook computer used to implement, test, and store all PLC and OIU application software programming. Install and configure all PLC and OIU vendor software packages and licenses onto laptop. Complete and save application software to notebook computer and to backup R/W CD(s).

Specifications:

Processor 2650: Intel Pentium 4-M processor at 2.0 GHz, 512 KB cache.

Memory: 128 MB DDR SDRAM standard, upgradable to 512 MB maximum, SDRAM configurations include one of 128, 192, 256, 384 or 512 MB.

I/O Ports:

25-hole pin parallel connector.
15-pin monitor connector.
6-pin PS/2-style keyboard, mouse, and keypad.
2-USB (Universal Serial Bus) compliant 4-pin connectors.
RJ-11 connector for modem.
RJ-45 connector for connection to Ethernet multimedia switch.
Chassis:

14.1-inch XGA Display: Height: 36 mm (1.42-inch); width: 328 mm (12.9-inch); depth: 275 mm (10.8-inch); weight: 7.25 lbs. with CD, floppy and battery.

Display: Displays 15-inch SXGA+ TFT active-matrix display with 1400 x 1050 resolution; height: 38 mm (1.5-inch); width: 332 mm (13.1-inch); depth: 275 mm (10.8-inch).

Power: Lithium Ion battery, AC Adapter: Input voltage: 90 to 135 VAC and 164 to 264 VAC.

Slots: Connectors: (1) Type I or Type II card, 3.3 and 5 V cards supported, Warm-swap Capable.

Graphics: 16MB DDR 4X AGP NVIDIA® GeForce2TM.

Storage: 20 GB4 Ultra ATA hard drive.

Optical Devices:

Fixed Bay integrated in left side with CD-RW: 24x/10x/24x max.

Removable Media: Fixed Floppy drive standard.

Communication Devices: Network Interface Cards, Integrated 10/100 network interface card.

Modems: Standard: Internal 56K5 capable v.92 Fax modem .

Software & Accessories: Microsoft® Windows® 2000 or XP Professional Small Business most recent version. Insure compatibility between platform and vendor software packages prior to installation.

Utilities: Norton AntiVirusTM 2003, introductory version.

Manufacturer and Model: Dell Inspiron 2650 or equal.

Y51 AutoDialer:

General:

Function: The Auto-dialer shall be a solid state component capable of bidirectional communication with the PLC network via cellular phone.

Environmental:

Operating Temperature Range: minus 6°C to 54°C

Relative Humidity: 0 to 95%, noncondensing.

Case: Suitable for mounting inside panel enclosure.

Features:

System Security: Access protected by security codes.

Alarm Monitoring: Continuously monitors all IDF alarms.

Remote Data-Table Access: Monitor or alter any data table location on demand via front panel or telephone.

Protocol: Allen-Bradley DFl.

Latency: 01-10 seconds.

Rotary pulse or tone dialing, keyboard selectable.

Dial up to 16 different numbers, each up to 60 digits long.

FCC Registered Part 68, “Ringer Equivalence”: 0.3A.

Alarm Acknowledgment shall be Touch-Tone key or by calling back.

Autodialer shall be compatible with most cellular telephone systems.

Provide Serial Cable for use with AB SLC.

Autocall Test.

Nonvolatile Program Memory Retention.

Local Data Logging.

Primary Power:

Voltage: 120 VAC, 50/60 Hz

Standby Supply Current: 300mA.

Operational Supply Current: 460mA.

Battery backup: The product is to contain its own gel cell rechargeable battery, which is automatically kept charged when AC power is present. The system shall operate on battery power for a minimum of 13 continuous hours in the event of AC power failure.

Surge protection: All power, phone line, dry contact, and analog signal inputs shall be protected at the circuit board to IEEE Standard 587, category B (6,000 volts open circuit/3,000 amps closed circuit).

Diagnostics:

The unit shall include user commands to execute diagnostics of the PLC network to determine the health of the network. The unit shall inform the user of the length of scan time for the set of all configured remote channels.

AC Power failure.

Remote (PLC) Channel Monitoring: failure of the active serial communications channels.

Input Monitoring: with configurable aux contacts.

Warranty: The autodialer shall be covered by not less than a two (2) year warranty covering parts and labor performed at the Factory.

Agency Approvals:

FCC Part 68.

Manufacturer and Product: RACO Verbatim Gateway Alarm Dialer or equivalent.

Y52 Cellular Modem (CDMA):

General:

Function: The Fixed Wireless Terminal shall provide wireless connectivity for standard telephone equipment.

Environmental:

Operating temperature range: -10°C to +50°C.

Storage temperature range: -40°C to + 60°C.

Relative Humidity: 5% to 95%.

Case: Suitable for mounting inside panel enclosure.

Features:

Compatible with popular supplementary services including caller ID, call waiting, 3-way calling, and call forwarding.

Single jack or dual jack for voice and fax operation.

PSTN Emulation.

Support up to five phones (5 REN).

Emergency battery backup.

Automatic end-of-dialing (no SEND key).

LED Indicators: shall include power/battery status, signal status, message status, and ON/OFF hook status.

Primary Air Interface Standard:

TIA/EIA/IS-2000A.

Primary Transmit Power:

200 mW (23dBm).

Frequency Ranges: Transmit/Receive:

CDMA800 824-849 MHz 869-894 MHz.

PCS (CDMA) 1900 1850-1910 MHz 1930-1990 MHz.

Primary Power:

Voltage: 110 - 230 VAC, 50/60 Hz.

Battery backup: One (1) 6-volt, 4 AH lead acid rechargeable battery.

Connectors:

Two RJ-11 interface jacks for telephone, Group 3 analog fax, or analog data.

TNC antenna connector (50 ohms).

Antennae:

Gain: 8.0 dBi minimum

Frequency Bands: 824 - 1000 and 1700 - 2000 MHz.

VSWR: Transmit sub-bands < 1.5:1, Receive sub-bands < 2.0:1.

Front to Back Ratio: (F/B Ratio) > 16 dB (nom).

Feed power handling: 10 W.

Nominal input impedance: 50 Ohms.

Connector: TNC male on short coax (30 - 50 cm).

Polarization: Linear (vertical when clamped to vertical pole).

Mounting: Pole mount, maximum diameter: 50 mm (2”).

Model Number: HGD-0 “High Gain Log Periodic Dipole Array”.

Warranty: The Cellular modem shall be covered not less than a fifteen (15) month warranty covering parts and labor performed at the Factory.

Agency Approvals:

FCC Part 15/Part 22/Part 24 Class B Compliance

Manufacturer and Product: Phonecell® SX4E CDMA or approved equivalent.

Y178A Programmable Data Logger, Integral Solar Powered:

General:

Function: Programmable data logger and system capable of interfacing with process measurements loop powered analog device(s) for the purpose of measuring, collecting, storing and serially transferring process level data with externally connected programming and storage device (i.e. laptop computer).

Type: Microprocessor based.

Parts: Data logger, input/output channel, signal converter, communications, rechargeable battery, solar panel, charge controller, enclosure, and programming and data retrieval software. Vendor shall provide complete system meeting the intent of these specifications and contract drawings.

Service: Interface with Level/Element Transmitter, Submersible, Wastewater (Reference Section 13401 PICS Component L42 for detail information, Druck PTX 1830 and STE110 Level Element/Transmitter Submersible 12 V dc compatible or equal).

Performance:

Environmental:

Operating Temperature: Minus 67 degrees F to plus 185 degrees F (minus 25 to plus 85 degrees C), with gel cell battery, minus 40 degrees F to plus 140 degrees F (minus 40 to plus 60 degrees C).

Relative Humidity: 5 to 95 percent, non-condensing.

Central Processing Unit (CPU):

Processor: Hitachi 6303.

Memory: table based memory structure 62,000 data points.

Real time clock.

Diagnostic LEDs.

12-bit A/D converter.

16kB active program.

128kB operating and flash final storage.

Comm Port: 9-pin D type connector for RS232 interface with PC; up to 9600 baud selectable baud rates.

Manufacturer and Model: Campbell Scientific; CR510 Series with extended temperature test.

Input/Output Channel:

Analog Inputs:

Two (2) differential or four (4) single ended configured.

Range: 0 to 2.5 V dc.

Accuracy: +/-0.25 percent.

Resolution: 0.33 uV.

Sample Rates: 2.72 ms adjustable.

Manufacturer and Model: Campbell Scientific; Model CR510.

Terminal Input Channel Converter:

Convert 4-20mA to datalogger input range of 0 to 2.5V dc.

Shunt Resistor: 100 ohms.

Tolerance: +/- 0.01 percent.

Power: 0.25 watt.

Manufacturer and Model: Campbell Scientific; Model CURS100.

DC Power Supply:

Solar Panel, Regulator and Mounts:

Solar panel converting sunlight to DC power.

Voltage Peak: 16.8 volts.

Current at Peak, amps: 1.19 amps.

Peak Power: 20 watts.

Manufacturer and Model: Campbell Scientific; Model MSX20R.

Rechargeable Power Supply with Batteries:

Rechargeable power supply capable of recharging batteries from solar power.

Sealed rechargeable batteries providing 7.0 AHRS nominal output at 68 degrees F (20 degrees C).

Float charged by solar panel.

Manufacturer and Model: Campbell Scientific; Model PS100.

Enclosure: NEMA 4X - fiberglass reinforced polyester (FRP) 16 inches wide by 18 inches high by 9 inches deep (minimum) sized to accommodate datalogger, input/output channels, DC power supply, and sensor terminations.

Enclosure Mounting: Wall or pipe mounting as required.

Power Requirements: 5.4V dc to 16V dc.

Software Language: Pakbus operating system, and Microsoft® Windows® 2000 or XP based Datalogger Support and editing software and licenses complete and latest versions.

Support: Two (2) eight-hour days in support of installation, startup, calibration, and testing of complete system.

Training: One (1) eight-hour day in support of Tank Farm Contractor training on operations, setup, data retrieval, and troubleshooting of complete system.

Warranty: Three (3) years complete system beginning after system installation is complete and tested.

Manufacturer: Campbell Scientific.

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
1	1	219(Y)	LH	FIT	203	Leachate Collection and Removal System High Flow Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/00	No. 1	
2	1	219(Y)	LH	FIT	202	Leachate Collection and Removal System Low Flow Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/01	No. 1	
3	1	219(Y)	LH	FIT	204	Leak Detection System Pump Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/02	No. 1	
4	1	219(Y)	LH	LT	101	Leachate Collection and Removal System Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/03	No. 2	
5	1	219(Y)	LH	LT	104	Leak Detection System Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/04	No. 2	
6	1	219(Y)	LH	TIT	219	Crest Pad Building Temperature	H-2-830854 Sheet 1 of 4	Fahrenheit	4-20mA	I:01/05	No. 3	
7	1	219(Y)201	LH	LT	301	Leachate Storage Tank Level	H-2-830854 Sheet 1 of 4	Inches	4-20mA	I:01/06	No. 2/ No. 6	Add Signal Isolator
8	1	219(Y)1	LH	FIT	302	Leachate Transfer Pump Discharge Flow	H-2-830854 Sheet 1 of 4	GPM	4-20mA	I:01/07	No. 1/ No. 6	Add Signal Isolator

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
9	1	219(Y)1	LH	TIT	220	Leachate Transfer Building Temperature	H-2-830854 Sheet 1 of 4	Fahrenheit	4-20mA	I:02/00	No. 3	
10	1	219(Y)	LH			Spare Input			4-20mA	I:02/01		Wire in spare inputs
11	1	219(Y)	LH			Spare Input			4-20mA	I:02/02		Wire in spare inputs
12	1	219(Y)	LH			Spare Input			4-20mA	I:02/03		Wire in spare inputs
13	1	219(Y)	LH			Spare Input			4-20mA	I:02/04		Wire in spare inputs
14	1	219(Y)	LH			Spare Input			4-20mA	I:02/05		Wire in spare inputs
15	1	219(Y)	LH			Spare Input			4-20mA	I:02/06		Wire in spare inputs
16	1	219(Y)	LH			Spare Input			4-20mA	I:02/07		Wire in spare inputs
17	1	219(Y)	LH	HS	203	Leachate Collection and Removal System High Flow Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/00	No. 4	
18	1	219(Y)	LH	YL	203	Leachate Collection and Removal System High Flow Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/01	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
19	1	219(Y)	LH	HS	202	Leachate Collection and Removal System Low Flow Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/02	No. 4	
20	1	219(Y)	LH	YL	202	Leachate Collection and Removal System Low Flow Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/03	No. 4	
21	1	219(Y)	LH	HS	204	Leak Detection System Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/04	No. 4	
22	1	219(Y)	LH	YL	204	Leak Detection System Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/05	No. 4	
23	1	219(Y)	LH	LSH	105	Crest Pad Building Sump Level High	H-2-830854 Sheet 1 of 4	High/Normal	24V dc	I:03/06	No. 4	
24	1	219(Y)	LH	LSHH	105	Crest Pad Building Sump Level High High	H-2-830854 Sheet 1 of 4	High-High /Normal	24V dc	I:03/07	No. 4	
25	1	219(Y)	LH	LSL	105	Crest Pad Building Sump Level Low	H-2-830854 Sheet 1 of 4	Low/Normal	24V dc	I:03/08	No. 4	
26	1	219(Y)	LH	LDE	105	Crest Pad Building Sump Leak Detector	H-2-830854 Sheet 1 of 4	Leak/Normal	24V dc	I:03/09	No. 4	
27	1	219(Y)	LH	JSH	219	Crest Pad Building	H-2-	Normal/Fail	24V dc	I:03/10	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
						Power Status	830854 Sheet 1 of 4					
28	1	219(Y)	LH	HS	205	Crest Pad Building Sump Pump Auto Status	H-2-830854 Sheet 1 of 4	On/Off/Auto	24V dc	I:03/11	No. 4	
29	1	219(Y)	LH	YL	205	Crest Pad Building Sump Pump On Status	H-2-830854 Sheet 1 of 4	On/Off	24V dc	I:03/12	No. 4	
30	1	219(Y)	LH	HS	219	Crest Pad Building General Alarm Acknowledge Status	H-2-830854 Sheet 1 of 4	Acknowledge/Off	24V dc	I:03/13	No. 4	
31	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:03/14	No. 4	Wire in spare inputs
32	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:03/15	No. 4	Wire in spare inputs
33	1	219(Y)	LH			Spare	H-2-830854 Sheet 1 of 4		24V dc	I:04/00	No. 4	Wire in spare inputs
34	1	219(Y)201	LH	LSHH	301	Leachate Storage Tank Level Switch	H-2-830854 Sheet 2 of 4	High High/Normal	24V dc	I:04/01	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
35	1	219(Y)201	LH	LSLL	301	Leachate Storage Tank Level Switch	H-2-830854 Sheet 2 of 4	Low Low /Normal	24V dc	I:04/02	No. 4	
36	1	219(Y)	LH			Spare			24V dc	I:04/12	No. 4	Wire in spare inputs
37	1	219(Y)1	LH	YL	302-2	Leachate Transfer Pump On Status	H-2-830854 Sheet 2 of 4	On/Off	24V dc	I:04/04	No. 4	
38	1	219(Y)	LH	LSHH	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	High High/Normal	24V dc	I:04/05	No. 4	
39	1	219(Y)	LH	LSH	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	High /Normal	24V dc	I:04/06	No. 4	
40	1	219(Y)	LH	LSL	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	Low/Normal	24V dc	I:04/07	No. 4	
41	1	219(Y)	LH	LSLL	107	Combined Sump Level Switch	H-2-830854 Sheet 2 of 4	Low Low/Normal	24V dc	I:04/08	No. 4	
42	1	219(Y)	LH	LDE	107	Combined Sump Leak Detector	H-2-830854 Sheet 2 of 4	Leak/Normal	24V dc	I:04/09	No. 4	
43	1	219(Y)	LH	HS	207	Combined Sump Pump Auto Status	H-2-830854	On/Off/Auto	24V dc	I:04/10	No. 4	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
							Sheet 2 of 4					
44	1	219(Y)	LH	YL	207	Combined Sump Pump On Status	H-2-830854 Sheet 2 of 4	On/Off	24V dc	I:04/11	No. 4	
45	1	219(Y)	LH			Spare			24V dc	I:04/12	No. 4	Wire in spare inputs
46	1	219(Y)	LH			Spare			24V dc	I:04/13	No. 4	Wire in spare inputs
47	1	219(Y)	LH			Spare			24V dc	I:04/14	No. 4	Wire in spare inputs
48	1	219(Y)	LH			Spare			24V dc	I:04/15	No. 4	Wire in spare inputs
49	1	219(Y)	LH	YS	203	Leachate Collection and Removal System High Flow Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/00	No. 4	Note: Interlock Control
50	1	219(Y)	LH	YS	202	Leachate Collection and Removal System Low Flow Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/01	No. 4	Note: Interlock Control
51	1	219(Y)	LH	YS	204	Leak Detection System Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/02	No. 4	Note: Interlock Control
52	1	219(Y)	LH	YS	219	Crest Pad Building General Alarm	H-2-830854 Sheet 1	Normal/Fail	120 Vac	O:05/03	No. 5	

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
							of 4					
53	1	219(Y)	LH	YS	205	Crest Pad Building Sump Pump Start Command	H-2-830854 Sheet 1 of 4	Start/Stop	120 Vac	O:05/04	No. 4	Note: Interlock Control
54	1	219(Y)	LH	YS	207	Combined Sump Pump Start Command	H-2-830854 Sheet 2 of 4	Start/Stop	120 Vac	O:05/05	No. 4	Note: Interlock Control
55	1	219(Y)1	LH	YS	220	Leachate Transfer Building General Alarm	H-2-830854 Sheet 2 of 4	Normal/Fail	120 Vac	O:05/06	No. 4	Note: Interlock Control
56	1	219(Y)	LH			Spare Output			24V dc	O:05/07	No. 5	
57	1	219(Y)	LH			Spare Output			24V dc	O:06/00	No. 4	Wire in spare outputs
58	1	219(Y)	LH			Spare Output			24V dc	O:06/01	No. 4	Wire in spare outputs
59	1	219(Y)	LH			Spare Output			24V dc	O:06/02	No. 4	Wire in spare outputs
60	1	219(Y)	LH			Spare Output			24V dc	O:06/03	No. 4	Wire in spare outputs
61	1	219(Y)	LH			Spare Output			24V dc	O:06/04	No. 4	Wire in spare outputs
62	1	219(Y)	LH			Spare Output			24V dc	O:06/05	No. 4	Wire in spare outputs
63	1	219(Y)	LH			Spare Output			24V dc	O:06/06	No. 4	Wire in

Item	Rev	Tag 1 Area	Tag 2 Process	Tag 2 ISA	Tag4 Loop	Description	P&ID	Engineering Units	Voltage/ Current	Address	Typical Wiring Diagram	Notes
												spare outputs
64	1	219(Y)	LH			Spare Output			24V dc	O:06/07	No. 4	Wire in spare outputs
65	1	219(Y)	LH	HS	001	Handswitch in Interlock Relay Cabinet						
66	1	219(Y)	LH	YL	001	Indicator Light in Interlock Relay Cabinet						

(Y) = A for Cell No. 1. For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.
(Y) = E for Cell No. 2. For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.

Loop Descriptions

Supplement 4 **PLC and OIU Application Software**

DOCUMENT OBJECTIVES

This Supplement No. 4 to Specification Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS) provides the basis for estimating the minimum level of effort required to implement PLC and OIU application software for Cell No. 1 and Cell No. 2 Integrated Disposal Facilities (IDF).

Unless otherwise directed by the Tank Farm Contractor during Application Software Submittal and Design Workshops, this document provides guidelines for the programming and testing of all PLC and OIU application software. *Note: Issues related to Application Software Submittal and Design Workshops are discussed in Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS).*

This Supplement No. 4 shall be used in conjunction with Contract Documents (drawings and specifications, and supplements) and relevant PICS supplier technical information and manuals while developing application software.

PICS Supplements shall be provided to Construction General Contractor in electronic format upon request.

Reference Management Directive TFC–MD–034, Rev. A, attached to this supplement for directives on HMI (OIU) configurations.

PLC AND OIU PROGRAM LAYOUT

1. Programmable Logic Controller (PLC) Application Software: Provide PLC application software as necessary for a fully functional and operable PLC system in accordance with the project design. PLC programming includes, but shall not be limited to the following:
    a. PLC application software development and installation
    b. PLC equipment configuration
    c. PLC interface with Operator Interface Unit (OIU)
    d. System testing
    e. PLC application software debugging and trouble-shooting
    f. System hardware and software documentation
    g. PLC system startup
    h. PLC system training.
2. ETHERNET Address: For more information on SLC500 Ethernet Addressing see Allen-Bradley Quick Start Ethernet SLC500 Processor > Publication 1747-10.4.
    a. Host Name: (To be assigned by Tank Farm Contractor)
    b. IP Address: (To be assigned by Tank Farm Contractor)
    c. Subnet Masking: 255.255.255.0
    d. Gateway address: None
3. PLC Memory Allocation: Provide PLC programming and documentation with logical, structured groupings of PLC memory registers. Allocate memory within each group to allow for 50 percent spare capacity. Examples of functional groupings shall be:
    a. Inputs > I:01/00
    b. Outputs > O:01/00

c. Control Operation Bits > B3:0 through B3: 200
d. Timers > T4:0 through T4:100
e. Counter > C5:0 through C5:100
f. Sequencers > R6:0 through R6:100
g. Ethernet Diagnostic Files > N7:00 through N7:50
h. Scaled Analog Inputs > F8:00 through F8:49
i. Process Calculations, Runtime, and Flow Totalization > F8:50 through F8:100
j. Process Set-points, Comparisons, and Scaling Ranges for Analog Inputs > F9:0 through F9:100
k. Reserve for future SCADA Discrete Write Commands to Processor > N10:0 through N10:100
l. Reserve for future SCADA Analog Write Commands from Processor > F11:0 through F11:100
m. Reserve for future SCADA Discrete Read Status from Processor > N12:0 through N12:100
n. Reserve for future SCADA Analog Read Status from Processor > F13:0 through F13:100
o. Reserve for future PID Control Files > MG14:0 or N14:0
p. Reserve for future Messaging > N15
q. Other Diagnostic Files > N16

4. PLC Programming Sub-routines: Divide PLC program into logical sub-routines. Each sub-routine shall contain the programming for a process or set of equipment. Examples of logical subroutines include:

a. Ethernet Communication
b. Process flow, level, and temperature signal scaling, totalizing and alarming
c. Landfill leachate collection and removal system pump control
d. Landfill leak detection system pump control
e. Landfill crest pad building sump pump monitoring
f. Landfill crest pad building miscellaneous control
g. Leachate storage tank level measurement and leak detection
h. Leachate collection and transmission line leak detection
i. Leachate transfer pump control and flow totalization
j. Combined sump pump control and leak detection
k. Leachate transfer building miscellaneous control.

5. PLC Program Documentation: Each PLC program shall be fully annotated with descriptive notations that define the functions associated with each program element. Provide the following minimum level of program documentation.

a. Each program element shall have a descriptive name associated.
b. Each program sub-routine and article associated within a major program shall be proceeded by a description of the sub-routine and article function.
c. Each major program shall be proceeded by a description of the program and a listing of the associated program sub-routines and articles.

6. The program documentation shall be developed using the PLC suppliers standard program documentation software. The PLC program documentation shall also include a complete cross reference listing of all program elements and their location within each program.

7. Program OIU to enable secured access to process set-points and control modes of operation. OIU shall be configured with process status display screens, set-point entry, equipment control mode, equipment runtime, flow totaling, alarm status, and alarm enable/disable screens. Process set-point and equipment control mode shall be implemented using RETURN ENTRY at the control panel mounted OIU.

8. Program OIU with three (3) security levels: engineer, operator, and system administrator. Engineer shall have access to all displays. Operator shall have access to all process status and alarm display screens but not control mode, alarm enable/disable, and set-point screens. Administrator shall have access to process status, and alarm enable/disable screens.

9. Configure and link OIU Main Menu, Sub-Menu and Data screens in a logical fashion allowing Operator(s) to logically move through each process control loop, with the ability to access data entry set-point and control modes.

10. Program and configure alarm screens for each alarm as described in Section 3.2 PLC Loop Descriptions of this Supplement. OIU alarm screens shall enable operator(s) to visually identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at local alarm display ONLY.

11. Program and configure AutoDialer for each alarm as described in Section 3.2 PLC Loop Descriptions of this Supplement. Autodialer alarm options shall enable operator(s) to identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at Autodialer ONLY.

PLC & OIU PROGRAMMING

PLC STANDARD FUNCTIONS

1. General — PICS shall implement functions for the purpose of program standardization and minimum PLC application software capability. Functions may not be applicable to every program control loop or network.

2. PLC Standard Function No. 1 — Equipment Run Timers: For each equipment ON status input, track the runtime of the associated equipment item. Accumulate equipment runtime in tenths of hours using retentive timers with no timer reset due to equipment stoppage or power loss. Provide a command interface to allow reset or adjustment of equipment run time.

3. PLC Standard Function No. 2A — Equipment Failure Detection: Provide for each equipment item controlled by the PLC for which the PLC receives ON and AUTO or REMOTE status signals. Monitor for a fail condition when the unit is in the AUTO or REMOTE mode. A failure condition shall be activated when the unit is commanded by the PLC to run, and the PLC does not receive the unit's ON status signal after a 10-second delay period. When a failure condition is detected, inhibit the PLC run command to the unit. Reset the failure condition when the unit is taken out of AUTO or REMOTE mode.

4. PLC Standard Function No. 2B — Equipment Flow Failure Detection: Provide for each pump controlled by the PLC for which the PLC receives a PLC receives ON and AUTO or REMOTE, status and a PUMP DISCHARGE flow signal. Monitor for a fail condition when the unit is in the AUTO or REMOTE mode. A failure condition shall be activated when the unit is commanded by the PLC to run, and the PLC does not receive or maintain a positive flow value for a 10-second delay period. When a failure condition is detected, inhibit the PLC run command to the unit. Reset the failure condition when the unit is taken out of AUTO or REMOTE mode.

5. PLC Standard Function No. 3 — Analog Signal Scaling: Provide program logic to scale process analog signals to engineering units that correspond to the calibrated range of the field sensor. Store the scaled value in a PLC memory register for use in process control programming and for transmission to the OIU. Program PLC to monitor each analog input and ALARM in the event a

process signal is out of the 4-20mA range. A process signal out-of-range ALARM condition shall prevent associated process control from taking place. Program PLC and OIU such that in the event a process signal is out-of-range, data point on OIU shall change to color YELLOW enabling personnel to know the data is incorrect.

6. PLC Standard Function No. 4 — Analog alarms: Provide the capability to detect and annunciate alarms, such as high-high, high, low, and low-low for analog process signals. The PLC shall continuously compare the scaled process signal to a set-point value stored in PLC register memory. If the scaled process signal exceeds the alarm set-point, the PLC shall initiate an alarm signal to the OIU system and to external annunciation equipment as noted in the Process Control Loop Descriptions. The analog alarm function shall also have the following capabilities:

   a. Provide time delays on all alarm set-points. When the PLC detects the scaled process signal exceeding set-point, initiate the alarm delay timer. At the end of the time delay, activate the alarm.
   b. Unless specified in the Loop Functional Descriptions, all analog alarms shall be self resetting. The PLC shall reset the alarm condition when the scaled process signal value is within the set-point value plus a 2 percent deadband.
   c. Where noted in the Loop Functional Descriptions, provide alarm ENABLE/DISABLE program logic that respond to commands from the OIU. Suppress the activation of alarms when commanded to the DISABLE mode.
   d. Provide program logic to receive, and store in PLC register memory, alarm set-point commands from the OIU.

7. PLC Standard Function No. 5 — Discrete alarms: Provide adjustable alarm delay timers on all discrete alarm input signals monitored by the PLC. Upon detection of the alarm condition, the PLC shall initiate the time delay. At the end of the time period, the PLC shall communicate the alarm condition to the OIU system and to external annunciation equipment as noted in the Process Control Loop Descriptions. The discrete alarm function shall also have the following capabilities:

   a. Unless specified in the Loop Functional Descriptions, all discrete alarms shall be self resetting. The PLC shall reset the alarm condition when the alarm input signal resets.
   b. Where noted in the Loop Functional Descriptions, provide alarm ENABLE/DISABLE program logic that respond to commands from the OIU. Suppress the activation of alarms when commanded to the DISABLE mode.

8. PLC Standard Function No. 7 — Process Flow Totalizers: For all process flow signals provide program logic in the PLC to accumulate flow totals and flow total RESET. The totaled value stored in the PLC shall be transmitted to the OIU for display and historical logging. PLC shall increment flow total when pump ON status and minimum flow status is confirmed.

9. PLC Standard Function No. 8 — Pump Restart Time Delay: Provide adjustable delay timers in PLC program so as to prevent rapid restart of all pumps. An adjustable timer for each pump's AUTO start control logic, shall begin to countdown once a pump has stopped operating. PLC shall not execute AUTO start control logic for each pump until respective adjustable delay timer's accumulated value is equal to preset value of 30 seconds, except for Pumps P-205 and P-207, which will have a 10-second delay period.

10. PLC Standard Function No. 9 — Power Failure: Program PLC to prevent PLC from executing process equipment automatic control during a power failure condition.

PLC LOOP DESCRIPTIONS

Note: Loop Descriptions are typical for both Cell No. 1 and Cell No. 2 process equipment.

1. Landfill Leachate Collection and Removal System (Loops 101, 202 and 203). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

   a. General — Landfill leachate collection and removal system consists of one collection sump, high and low flow collection pumps, one common level sensor, two flow transmitters, pump discharge piping, and ancillary valves. Pumps shall extract leachate from landfill collection and removal system sump and pump leachate to an above grade leachate storage tank via an underground double walled containment pipe. PLC shall monitor discharge flow from each pump via flow transmitters installed in each pump's discharge line. PLC shall automatically compute total extracted leachate from sump. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

   b. Program — Program PLC to implement continuous monitoring of liquid levels inside landfill leachate collection and removal sump and provide automatic operation of high and low flow pumps. Program PLC to automatically operate pumps ON/OFF based upon liquid levels inside the landfill leachate collection and removal system sump. PLC shall automatically operate pumps ON/OFF in order to insure that liquid levels over landfill liner - as measured from the bottom of the sump - do not exceed 12-inches. The PLC shall be programmed to automatically turn off the low flow pump when the high flow pump is called to run.

   c. AUTO Operation — Automatic operation requires operator(s) place each pump's respective ON-OFF-AUTO control switch (located at MCC) to AUTO mode. Pump operation and alarm set-points shall be entered at the control panel mounted OIU. The pumps shall operate between separate start and stop level set-points.

   d. Process Control Set-points — Operator(s) shall enter the following control set-points at the control panel mounted OIU:
      (1) High flow pump start level in inches
      (2) Low flow pump start level in inches
      (3) High flow pump stop level in inches
      (4) Low flow pump stop level in inches
      (5) Landfill leachate collection and removal system high-high level alarm in inches
      (6) Landfill leachate collection and removal system high level alarm in inches.

   e. REMOTE Operation — None.

   f. ON (manual) Operation — ON operation requires the following steps be taken by operator(s):
      (1) Operator(s) shall place high and low flow pump's respective ON-OFF-AUTO control switch (located at MCC) to ON mode.

   g. Interlocks — Interlocks shall prevent operation of leachate collection and removal pumps in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the landfill crest pad building sump, leachate storage tank or combined sump.

   h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:
      (1) Landfill leachate collection and removal system high-high level
      (2) Landfill leachate collection and removal system high level
      (3) Landfill leachate collection and removal system high flow pump fail
      (4) Landfill leachate collection and removal system low flow pump fail
      (5) Landfill leachate collection and removal system high flow pump flow fail
      (6) Landfill leachate collection and removal system low flow pump flow fail
      (7) Landfill leachate collection and removal system level signal fail

(8) Landfill leachate collection and removal system high flow pump flow signal fail
(9) Landfill leachate collection and removal system low flow pump flow signal fail.

i. Runtime and Flow Totaling — Program PLC to implement runtime and flow totals for each leachate collection and removal system pump. PLC increments equipment runtime and process flows when respective pump ON status and minimum flow status is confirmed. PLC control logic shall be programmed to allow runtime and flow value reset and adjustment.

2. Landfill Leak Detection System (Loops 104 and 204). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Landfill leak detection system consists of one leak detection sump, collection pump, one level sensor, flow transmitter, pump discharge piping , and ancillary valves. Leak detection system pump shall extract leachate from landfill leak detection sump and pump this leachate to an above grade leachate storage tank via an underground double walled containment pipe. PLC shall monitor discharge flow from leak detection pump via flow transmitter installed in pump's discharge line. PLC shall automatically compute total extracted leachate from sump. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement continuous monitoring of liquid levels inside landfill leak detection system chamber and provide automatic operation of leak detection pump. Program PLC to automatically operate leak detection pump ON/OFF based upon liquid levels inside leak detection sump.

c. AUTO Operation — Automatic operation requires operator(s) place leak detection pump's ON-OFF-AUTO control switch (located at MCC) to AUTO mode and enter sump pump operation control set-points at the control panel mounted OIU. The landfill leak detection system pump shall operate between separate start and stop level set-points.

d. Process Control Set-points – Operator(s) shall enter the following control set-points at the control panel mounted OIU:
(1) Leak detection system pump start level in inches
(2) Leak detection system pump stop level in inches
(3) Landfill leak detection system high-high level alarm in inches
(4) Landfill leak detection system high level alarm in inches

e. REMOTE Operation — None.

f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):
(1) Operator(s) shall place landfill leak detection pump's ON-OFF-AUTO control switch (located at MCC) to ON mode.

g. Interlocks — Interlocks shall prevent operation of leachate leak detection pump in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the landfill crest pad building sump, leachate storage tank, or combined sump.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:
(1) Landfill leak detection system high-high level
(2) Landfill leak detection system high level
(3) Landfill leak detection system pump fail
(4) Landfill leak detection system pump flow fail
(5) Landfill leak detection system level signal fail
(6) Landfill leak detection system flow signal fail

i. Runtime and Flow Totaling — Program PLC to implement runtime and flow totals for landfill leak detection pump. PLC increments equipment runtime and process flows when respective pump ON status and minimum flow is confirmed. PLC control logic shall be programmed to allow runtime and flow value reset and adjustment.

3. Landfill Crest Pad Building Sump System (Loops 105, 205). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

   a. General — Landfill crest pad building sump system consists of a building sump, sump pump, level floats, leak detection sensor, and pump discharge piping. Sump pump extracts and pumps liquids from building sump to an above ground leachate storage tank. Landfill crest pad building sump pump operates ON/OFF based upon actuation of level floats inside the landfill crest pad building sump. PLC shall monitor leak detection sensor. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.
   b. Program — Program PLC to monitor sump float switches and provide automatic operation of landfill crest pad building sump pump between high and low level status. In the event of high-high level condition, PLC shall alarm. In the event of a leak alarm condition PLC shall prevent operation of landfill leachate collection and leak detection pumps.
   c. AUTO Operation — Automatic operation requires operator(s) place sump pump's ON-OFF-AUTO control switch (located at MCC) to AUTO mode. The sump pump shall operate between start and stop levels. Operator(s) shall place sump leak detection ENABLE/DISABLE control switch (located at local sump control panel) to ENABLE leak detection control logic.
   d. Process Control Set-points — None
   e. REMOTE Operation — None
   f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):
      (1) Operator(s) shall place sump pump's ON-OFF-AUTO control switch (located at MCC) to ON mode.
   g. Interlocks — Interlocks shall prevent operation of landfill crest pad building sump pump in the event of a leachate storage tank high-high level alarm condition, or a leak alarm condition in either the leachate storage tank, or combined sump.
   h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:
      (1) Landfill crest pad building sump level high
      (2) Landfill crest pad building sump level high-high
      (3) Landfill crest pad building sump leak detected
      (4) Landfill crest pad building sump pump fail.
   i. Runtime — PLC shall provide runtime for sump pump. PLC increments equipment runtime when respective pump ON status is confirmed. PLC control logic shall be programmed to allow runtime value reset and adjustment.

4. Leachate Storage Tank System (Loops 300, 301). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

   a. General — Leachate storage tank system consists of an above grade tank with an outer steel wall, an interstitial leak detection chamber, floating cover, level sensors, leak detection sensors, and a transfer pump suction connection. Liquid is pumped to leachate storage tank from landfill leachate collection and leak detection pumps, landfill crest pad building sump pump, and combined sump. A level sensor located inside a stilling well - mounted inside the storage tank - provides continuous liquid levels measurements to PLC. This level sensor is backed-up by additional discrete level switches. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.
   b. Program — Program PLC to implement continuous monitoring of liquid levels inside leachate storage tank. Level measurements shall be displayed at control panel inside landfill crest pad building and local control panel inside leachate transfer building. Program PLC to

monitor level high-high and low-low switches which provide backup safety measurement and control for the continuous level sensor.

c. AUTO Operation — None.

d. Process Control Set-points:

(1) Leachate storage tank high-high level in inches

(2) Leachate storage tank high level in inches

(3) Leachate storage tank low level in inches

(4) Leachate storage tank low-low level in inches.

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — Interlocks shall prevent operation of landfill leachate collection and removal and leak detection pumps, crest pad sump pump, and combined sump pump in the event of a leachate storage tank high-high level condition alarm condition. Interlocks shall prevent operation of transfer pump in the event of a storage tank low-low level condition.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Leachate storage tank high-high level

(2) Leachate storage tank high level

i. Runtime – None.

5. Combined Sump Pump System (Loops 107, 207). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

a. General — Combined sump pump system consists of a sump assembly with dual chambers (pump chamber and leak detection chamber), sump pump, level floats, and a leak detection sensor. Liquids from truck loading station, gravity drain to the sump pump chamber. Liquids from containment piping, gravity drain to leak detection chamber. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to implement automatic operation of combined sump pump. Combined sump pump shall operate ON/OFF based upon actuation of discrete floats mounted inside sump: sump high-high alarm level, sump pump high (start) level, sump pump low (stop) level and sump pump low-low (alarm) level. Program PLC to alarm when high-high level float switch is activated or low-low level float is actuated and sump pump ON status exists. Program PLC to monitor operation of leak detection sensor. Sump floats and leak detection sensor shall be hardwired to intrinsic safety relay modules.

c. AUTO Operation — Automatic operation requires operator(s) place combined sump pump ON-OFF-AUTO control switch (located inside transfer building) to AUTO mode. Sump pump shall operate between sump pump start and stop levels.

d. Process Control Set-points — None.

e. REMOTE Operation — None.

f. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place sump pump ON-OFF-AUTO control switch (located inside transfer building) to ON mode

(2) Pump selected to ON mode shall continue to operate until sump pump low-low level is reached.

g. Interlocks — Interlocks shall prevent operation of combined sump pump in the event of a leachate storage tank high-high level alarm condition. Interlocks shall prevent operation of landfill leachate collection and leak detection pumps, and landfill crest pad building sump pump in the event of a combined sump leak alarm condition.

h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:

(1) Combined sump high-high level

(2) Combined sump low-low level
(3) Combined sump pump fail
(4) Combined sump leak detected.

i. Runtime — Program PLC to provide runtime. PLC shall increment equipment runtime when pump ON status is confirmed. Implement PLC control logic necessary to allow local runtime value reset and adjustment.

6. Leachate Transfer Pump System (Loop 302). Reference P&ID Drawing H-2-830854 sheet 2 of 4.

a. General — Leachate transfer pump system consists of a transfer pump with its suction line connected to leachate storage tank, discharge piping, flow meter, and a truck loading quick disconnect. System allows operator(s) to pump liquids from leachate storage tank to storage trucks. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor totalized flow from leachate storage tank to truck loading station for the purpose of determining amount of liquids being trucked off-site. Transfer pump operation is manual, with interlocks preventing transfer pump operation during a storage tank low-low level condition.

c. AUTO Operation — None

d. Process Control Set-points — None

e. REMOTE Operation — None

j. ON (manual) Operation — ON (manual) Operation requires the following steps be taken by operator(s):

(1) Operator(s) shall place transfer pump ON-OFF control switch (located inside transfer building) to ON mode. Operator(s) shall monitor totalized flow as a means of determining duration of transfer operation.

f. Interlocks — Interlocks shall prevent transfer pump operation during a storage tank low-low level condition.

g. Alarms— Program PLC to monitor process and alarm for the following minimum conditions:

(1) Truck Loading Station flow signal fail.
(2) Transfer Pump low flow fail.

h. Flow Totaling — PLC shall provide flow totals for truck loading station. PLC control logic shall allow for flow reset and value adjustment.

7. Control Panel Power Monitoring System (Loop 219). Reference P&ID Drawing H-2-830854 sheet 1 of 4.

a. General — Control panel power monitoring system consists of a control relay mounted inside landfill crest pad building control panel. Power to landfill crest pad building control panel is monitored by this control relay. In the event of a power failure, control relay drops out removing input status to PLC. The PLC (which is powered by a UPS) senses the loss of signal, and prevents automatic operation of process equipment. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.

b. Program — Program PLC to monitor power to control panel. In the event of a power failure, PLC program shall remove run command from all process equipment so as to prevent nuisance alarming and equipment failure. Program PLC to stagger start equipment after control power returns to normal.

c. AUTO Operation — None.

d. Process Control Set-points — None.

e. REMOTE Operation — None.

f. ON (manual) Operation — None.

g. Interlocks — Interlocks prevent operation of equipment in the event of loss of power to control panel.

h. Alarms — Program PLC to monitor and alarm control panel power for following minimum conditions:
   (1) Control Panel Power fail.
i. Runtime — None.

8. Crest Pad and Leachate Transfer Building Temperature Monitoring System (Loops 219, 220). P&ID drawings H-2-830854 sheets 1 & 2 of 4.

a. General — Crest pad and leachate transfer building temperature monitoring system consists of an ambient temperature transmitter which monitors the effective operation of building heating and cooling equipment. All process variables and equipment status shall be displayed locally via panel mounted OIU and digital indicators.
b. Program — Program PLC to monitor crest pad and leachate transfer building temperature levels and alarm in the event of temperature alarm condition signifying heating and cooling equipment failure.
c. Automatic Operation — None.
d. Process Control Set-points:
   (1) Landfill crest pad building temperature level high alarm in degrees F
   (2) Landfill crest pad building temperature level low alarm in degrees F
   (3) Leachate transfer building temperature level high alarm in degrees F
   (4) Leachate transfer building temperature level low alarm in degrees F
e. REMOTE Operation — None.
f. ON (manual) Operation — None.
g. Interlocks — None.
h. Alarms — Program PLC to monitor process and alarm for the following minimum conditions:
   (1) Landfill crest pad building temperature level high alarm
   (2) Landfill crest pad building temperature level low alarm
   (3) Landfill crest pad building temperature signal fail alarm
   (4) Leachate transfer building temperature level high alarm
   (5) Leachate transfer building temperature level low alarm
   (6) Leachate transfer building temperature signal fail alarm.
i. Runtime — None.

9. Building General Alarm System (Loops 219, 220). Reference P&ID Drawing H-2-830854 sheet 1, 2 of 4.

a. General — Building general alarm system consists of alarm lights installed on the exterior wall of the landfill crest pad building and leachate transfer building which are operated by the PLC. Alarm light provides a visual method of notifying operator(s) of a general alarm condition.
b. Program — Program PLC to monitor all process loops and initiate general alarm in the event of an alarm condition. General alarm shall continue until process alarm condition is acknowledged by operator(s). Acknowledge shall be initiated at pushbutton or OIU on landfill crest pad building control panel. Program PLC to receive acknowledgement during an alarm condition, to turn off general alarm light, and be able to initiate a new general alarm in the event of a new and subsequent alarm condition.
c. AUTO Operation — None.
d. Process Control set-points – None.
e. REMOTE Operation — None.
f. ON (manual) Operation — None.
g. Interlocks — None.
h. Alarms — (See previous loops).
i. Runtime — None.

OIU DISPLAYS AND LAYOUT

1. General — OIU shall be configured with process displays, data entry, runtime, and alarm screens. Process set-points and control modes shall be one-shot commands from the OIU.

2. Process display screens shall have a P&ID style of presentation. Displays shall include text for equipment and process identification. Data entry points and screens shall have a TABLE style of presentation.

3. Program OIU to enable secured access to process set-points and control modes of operation. OIU shall be configured with process status display screens, set-point entry, equipment control mode, equipment runtime, flow totaling, alarm status, and alarm enable/disable screens. Process set-point and equipment control mode shall be implemented using RETURN ENTRY at the control panel mounted OIU.

4. Program OIU with three (3) security levels: engineer, operator, and system administrator. Engineer shall have access to all displays. Operator shall have access to all process status and alarm display screens but not control mode, alarm enable/disable, and set-point screens. Administrator shall have access to process status, and alarm enable/disable screens.

5. Configure and link OIU Main Menu, Sub-Menu and Data screens in a logical fashion allowing operator(s) to logically move through each process control loop, with the ability to access data entry set-point and control modes as described in this document.

6. Program and configure alarm screens for each alarm as described in this document. OIU alarm screens shall enable operator(s) to visually identify and acknowledge all alarm conditions for each process control loop. Alarms shall be acknowledged at local alarm display ONLY. Acknowledge shall not be broadcast across network from OIUs.

7. Alarm Identifications:
   a. Process in Alarm and Unacknowledged: Flashing
   b. Process in Alarm and Acknowledged: Steady

8. Configure and link displays in a logical fashion allowing operator(s) to logically access all processes and select the following:

   a. IDF Process System Overviews (Displaying process levels, flows, and temperature for each system)
   b. Disposal Facility Equipment Runtime and Runtime Reset Display
   c. Disposal Facility Process Control Set-point Display(s)
   d. Disposal Facility Process Alarm Set-point Display(s)
   e. Disposal Facility Process Flow Totalization and Flow Totalization Reset Display
   f. Integrated Disposal Facility Alarm Display.

REFERENCE MANAGEMENT DIRECTIVE TFC–034, Rev. A

USQ #04-0016-AA

CH2M HILL Hanford Group, Inc.	**Manual**	**Management Directive**
	Revision	**TFC-MD-034, REV A**
GRAPHIC PROCESS DISPLAY	**Page**	**272 of 3**
CRITERIA FOR HUMAN-MACHINE	**Issue Date**	**January 9, 2004**
INTERFACES	**Effective Date**	**January 12, 2004**
	Expiration Date	**March 1, 2004**
FUNCTIONAL AREA MANAGER:		**D. C. Lowe**
DOCUMENT OWNER:		**R. E. Larson**

1.0 PURPOSE AND SCOPE

The purpose of this management directive (MD) is to establish the requirements for standardized criteria for new graphic process displays (human-machine interfaces) that are being designed or acquired for process monitoring and control systems of CH2M HILL Hanford Group, Inc. (CH2M HILL) facilities and managed projects.

The requirements of this MD are applicable to new monitoring and control system designs (Human-Machine Interfaces) for CH2M facilities and to projects that have not completed an Acceptance Test Procedure (ATP). Application of the MD requirements to existing human-machine interfaces systems and human-machine interfaces systems with a completed ATP will be determined, planned, and performed in accordance with the resolution of PER-2003-4039.

2.0 IMPLEMENTATION

This management directive is effective on the date shown in the header and will remain in effect until a new Graphic Process Display Criteria for Human-Machine Interface Standard is issued.

3.0 DIRECTIVE

The following requirements that are based on the national standard ISA-S5.5-1985, “Graphic Symbols for Process Displays,” are the Tank Farm Contractors (TFC) design requirement for new process monitoring and control systems (Human-Machine Interfaces).

3.1 General

The following general symbol usage standards apply:

1. The graphic process display will follow requirements specified in ISA-S5.5 standard.
2. The use of outline and solid (filled) symbol forms to indicate status is as follows:
   - An outline symbol form indicates an off, stopped, or nonactive state.
   - A solid (filled) symbol form indicates an on, running, or active state.
   - Status designation by use of solid or outline forms are particularly applicable to the rotating equipment and valves and actuators. In depicting valve position, use solid to show open (material flowing or active) and outline to show closed (material stopped or nonactive).
   - A symbol may be partially filled or shaded to represent the characteristic of the contents of a vessel, e.g. level, temperature, etc.

3.2 Color

The following standards are to be applied to the application of color to process displays:

1. The following color application guidelines are to be followed:
   - The number of colors in one display should be limited to the minimum necessary (typically 4 or less) to satisfy the process interface objectives of the display.
   - Compatible color combinations should be used.
   - Use color as a redundant indictor along with text, symbol, shape, size, reverse video, blinking, and intensity coding to preserve communication with individuals having limited color perception.
   - Colors are not to be used to indicate quantitative value.
2. Colors are to be assigned consistent with Tables 1-4.

Table 1. Unique Component Colors (e.g., Leak Detectors, Tanks).

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	White
In Service – Selected (No Alarm)	Green
Alarming (Unacknowledged)	Flash Red
Alarm (Acknowledged)	Solid Red
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)
Caution Alarm (Acknowledged)	Solid Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

Table 2. Pipe Colors

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	White
In Service – Selected (No Alarm)	Grey
In Service – Selected (with Air or Fluid Flow)	Green
Encasement Leak Detector Alarming (Unacknowledged)	Red with Flashing Text
Encasement Leak Detector Alarm (Acknowledged)	Solid Red
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)
Caution Alarm (Acknowledged)	Solid Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

Table 3. Valves Port Colors.

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
Out of Service	Black
In Service – Unselected	Grey*

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)	
State	**Fill Color**
In Service – Selected/Operable: Open Port (No Alarm)	Green
In Service – Selected/Operable: Shut Port (No Alarm)	White*
In Service – Operating: Transition	Yellow (All Ports)
Valve Position Alarm (Unacknowledged)	Flash Red
Valve Position Alarm (Acknowledged)	Solid Red
Caution Alarm	Flash Yellow (Amber)
Not Used (e.g., bypassed)	Border is white, fill color as noted above

* The grey color used for the unselected valve is for contrast with an unselected pipe (white), which assists the operator in distinguishing the pipe from the valve (operator influence from display screen tests). The white color used to identify a shut port on a valve is in contrast with the valve open ports (green) and with the selected pipe (grey) which assists the operator in distinguishing the pipe from the valve.

Table 4. Pump Colors.

(Outline colors and text shall be black (unless otherwise noted), display background to be tan or light blue)		
State	**Fill Color**	**Text**
Out of Service	Black	--
In Service – Unselected	White	--
In Service – Selected: Pump Off and Power Off (No Alarm)	Grey	Stopped
In Service – Selected: Pump Off and Power On (No Alarm)	Yellow	Stopped
In Service – Selected: Pump On (Rotating)	Green	Running
Pump Alarm (Unacknowledged)	Flash Red	Stopped
Pump Alarm (Acknowledged)	Solid Red	Stopped
Caution Alarm (Unacknowledged)	Flash Yellow (Amber)	Caution

4.0 RECORDS

No records are generated in the performance of this management directive.

5.0 REFERENCES

1. Instrument Society of America (ISA) S5.5-1985, “Graphic Symbols for Process Displays.”

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2

Rev	Tag 1	Tag 2	Tag 3	Tag 4	System Description	Setpoint Description	Drawing	Process Ranges	Eng. Units	Comments
	Area	Process	ISA	Eqt #						
1	219(Y)	LH	LAHH	101	Leachate Collection and Removal System	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	12.0 inches above LCRS 50' x 50' sump floor.	Inches	Actuate elevation 673.90
1	219(Y)	LH	LAH	101	Leachate Collection and Removal System	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	11.0 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.82, activates slightly above elevation that LCRS High Flow pump On activates
1	219(Y)	LH	LAHH	104	Leak Detection System	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	12.0 inches above LDS sump floor	Inches	Actuate elevation 671.90
1	219(Y)	LH	LAH	104	Leak Detection System	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	11.0 inches above LDS sump floor	Inches	Actuate elevation 671.82
1	219(Y)	LH	FALL	202	Leachate Collection and Removal System Low Flow Pump	Low Flow Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	5	gpm	Half of Design Flowrate of 10 gpm
1	219(Y)	LH	FALL	202	Leachate Collection and Removal System Low Flow Pump	Low Flow Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	180	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	LAM	202	Leachate Collection and Removal System	Low Flow Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	6.00 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.40
1	219A	LH	LAL	202	Leachate Collection and Removal System	Low Flow Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	0.65 inch above LCRS 50' x 50' sump floor	Inches	Actuate elevation 672.95
1	219E	LH	LAL	202	Leachate Collection and Removal System	Low Flow Pump Stop Level Setpoint	H-2-830854 sheet 3 of 4	1.75 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.04
1	219(Y)	LH	LAM	203	Leachate Collection and Removal System	High Flow Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	10.8 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.80
1	219A	LH	LAL	203	Leachate Collection and Removal System	High Flow Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	4.25 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.22

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2

Rev	Tag 1	Tag 2	Tag 3	Tag 4	System Description	Setpoint Description	Drawing	Process Ranges	Eng. Units	Comments
	Area	Process	ISA	Eqt #						
1	219E	LH	LAL	203	Leachate Collection and Removal System	High Flow Pump Stop Level Setpoint	H-2-830854 sheet 3 of 4	9.25 inches above LCRS 50' x 50' sump floor	Inches	Actuate elevation 673.67
1	219(Y)	LH	FALL	203	Leachate Collection and Removal System High Flow Pump	High Flow Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	74	gpm	Half of Design Flowrate of 147 gpm
1	219(Y)	LH	FALL	203	Leachate Collection and Removal System High Flow Pump	High Flow Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	40	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	FALL	204	Leak Detection System	Leak Detection Pump Flow Fail Setpoint	H-2-830854 sheet 1 of 4	1	gpm	Half of Design Flowrate of 2 gpm
1	219(Y)	LH	FALL	204	Leak Detection System	Leak Detection Pump Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	880	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.
1	219(Y)	LH	LAM	204	Leak Detection System	Leak Detection Pump Start Level Setpoint	H-2-830854 sheet 1 of 4	10.8 inches above LDS sump floor	Inches	Actuate elevation 671.80
1	219(Y)	LH	LAL	204	Leak Detection System	Leak Detection Pump Stop Level Setpoint	H-2-830854 sheet 1 of 4	5.25 inches above LDS sump floor	Inches	Actuate elevation 671.34
1	219(Y)	LH	TAH	219	Crest Pad Building	Temperature High Alarm Setpoint	H-2-830854 sheet 1 of 4	90	Fahrenheit	AC will allow 85 degrees F max temp
1	219(Y)	LH	TAL	219	Crest Pad Building	Temperature Low Alarm Setpoint	H-2-830854 sheet 1 of 4	45	Fahrenheit	Heater will allow 50 degrees F low temp
1	219(Y)1	LH	TAH	220	Transfer Building	Temperature High Alarm Setpoint	H-2-830854 sheet 1 of 4	90	Fahrenheit	AC will allow 85 degrees F max temp
1	219(Y)1	LH	TAL	220	Transfer Building	Temperature Low Alarm Setpoint	H-2-830854 sheet 1 of 4	45	Fahrenheit	Heater will allow 50 degrees F low temp

PLC AND OIU APPLICATION SOFTWARE SETPOINTS FOR CELLS NO. 1 AND NO. 2

Rev	Tag 1	Tag 2	Tag 3	Tag 4	System Description	Setpoint Description	Drawing	Process Ranges	Eng. Units	Comments
	Area	**Process**	**ISA**	**Eqt #**						
1	219(Y)201	LH	LAHH	301	Leachate Storage Tank	High High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	74.4 inches above tank floor at wall	Inches	Actuate elevation 728.33, Activates at same elev as Hardware HH switch (at max operating capacity 6.2'), allowing 2 ft of freeboard
1	219(Y)201	LH	LAH	301	Leachate Storage Tank	High Alarm Level Setpoint	H-2-830854 sheet 1 of 4	Activates at 24 inches above tank floor at wall	Inches	Actuate elevation 724.13, reserving 4.2 ft operating capacity for design storm event
1	219(Y)201	LH	LAL	301	Leachate Storage Tank	Low Alarm Level Setpoint	H-2-830854 sheet 1 of 4	Activates just before falling water level reaches Hardware LL (7.8 inches above tank floor at wall) setpoint	Inches	Actuate elevation 722.78 (approximately 1 - 9,000 gallon truck load above the Low Low Setpoint)
1	219(Y)201	LH	LALL	301	Leachate Storage Tank	Low Low Alarm Level Setpoint	H-2-830854 sheet 1 of 4	6 inches above tank floor at wall	Inches	Activates at same elev as Hardware LL switch, activates just before falling water level reaches 6 inches above tank floor (722.63), assuring transfer pump does not run dry
1	219(Y)1	LH	FALL	302-1	Leachate Transfer Pump	Transfer Pump Low Flow Fail Setpoint	H-2-830854 sheet 1 of 4	125	gpm	Half of Design Flowrate at 250 gpm
1	219(Y)1	LH	FALL	302-1	Leachate Transfer Pump	Transfer Pump Low Flow Fail Timer Setpoint	H-2-830854 sheet 1 of 4	10	Seconds	Conservative approximation for time needed to fill empty discharge piping plus 20%. Can refine during testing.

(Y) = A for Cell No. 1
(Y) = E for Cell No. 2

For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.
For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.

1 **DIVISION 14** (NOT USED)

DIVISION 15 (NOT USED)

SECTION 15021 – HIGH DENSITY POLYETHYLENE (HDPE) PIPE Sched. B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing leachate piping and associated components.

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Recognizing some requirements of the references cited below may not be applicable, the Engineer shall judge the applicability of compliance with the references not specifically addressed herein. In the event of a conflict between the text of this Specification and the references cited herein, the text of this Specification shall take precedence or as directed by the Engineer.

ASTM INTERNATIONAL (ASTM)

ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials.
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D2513	Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F714	Standard Specification for Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter.

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192.285	Plastic pipe; qualifying persons to make joints.

DESCRIPTION:

Pipe: This section includes all high density polyethylene (HDPE) pipe used in the cells including but not limited to:

Leachate collection piping on floor and cleanout access pipes on the slopes of the trench.

Leachate discharge piping, leak detection piping, and associated riser pipes.

Double containment piping outside the cell (e.g., leachate force main and drain lines) and elsewhere as shown on the Drawings.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's design guidance that includes spacer maximum spacing, attachment method, orientation and material type.

Manufacturer's certificates of compliance for all pipe and fittings. Certificates shall acknowledge that pipe and fittings meet the requirements of the Specifications.

Descriptive literature about the fusion equipment to be used and certification from the pipe supplier or manufacturer that the joining technician(s) is certified and experienced in heat fusion joining of HDPE pipe. Certification shall contain the following minimum information:

Name of technician.
Date of certification.
Statement by the pipe supplier that the technician is certified in the means and methods of joining the supplier's pipe and fittings using butt fusion techniques.
Make(s) and model(s) of fusion equipment the technician is certified to join pipe with.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Catalog and manufacturer's data sheets for HDPE pipe and fittings.

Catalog and manufacturer's data sheets, electrofusion couplers, mechanical cutters, and appurtenances.

PART 2 – PRODUCTS

All HDPE pipe and fittings shall conform with additional applicable requirements defined in the Piping Schedule in Section 15060, PIPING-GENERAL.

HDPE PIPE:

Resin: HDPE pipe shall be manufactured from first quality extra-high molecular weight, high density polyethylene resin containing no more than 2 percent clean recycled polymer by weight. Resin shall meet or exceed the requirements of ASTM D3350 for PE3408 material with a cell classification of 345434C or higher. Alternate cell classifications are acceptable if one or more of the 6 numbers in the cell classification is greater than the minimum. Pipe shall be rated PE3408. Pipe and fittings shall be in compliance with schedule attached as supplement (see Attachment 1, HIGH DENSITY POLYETHYLENE (HDPE) PIPE) or as shown on the Drawings.

Quality: The pipe shall have uniform wall thickness and shall be uniform in color, opacity, density, and other physical properties. Pipe shall be homogeneous throughout and free of visible cracks, holes, blisters, bubbles, undispersed raw materials, or any contamination by foreign matter. Any pipe with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

Form: Pipe may be supplied in a continuous extruded seamless piece or in sections.

Manufacturer's Certificates of Compliance: The manufacturer shall submit a Certificate of Compliance of the HDPE pipe supplied for the IDF project, which will include that the pipe is grade PE3408 and the identity of the cell classification per ASTM D3350.

HDPE pipe SDR shall be as indicated on the Piping Schedule in Section 15060, PIPING-GENERAL.

Fittings: Fittings shall conform to the requirements of Article HDPE PIPE of this section, shall be compatible with components of the double containment system, and HDPE manholes where required.

Polyethylene fittings shall be from the same manufacturer as the pipe (or approved equal), molded or fabricated from polyethylene pipe and shall have the same or numerically smaller SDR than pipe connecting to the fitting. Fittings shall follow requirements in Attachment 1.

All reducing tees shall be factory molded if available as a standard item by any manufacturer having pipe meeting this section. If not available as a standard item, branch saddle reducing tees shall be used. Reducers shall be shop manufactured. Fabricated branch connections will not be allowed if branch saddle connections are listed in the manufacturer's catalog.

All molded polyethylene fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. All fabricated polyethylene fittings shall have the same or higher pressure rating as the adjoining pipe when installed in accordance with the manufacturer's recommendations.

DOUBLE CONTAINMENT PIPE:

Pipe Materials: Both carrier pipe and containment pipe shall meet the requirements of Article HDPE PIPE of this section.

Configuration: Double containment pipe shall consist of a carrier pipe installed within a containment pipe. All pipe and fittings shall provide an annular space between the carrier and containment pipes to accommodate possible flow of fluid from the carrier pipe.

Support Spacers: Support spacers shall be manufactured from nonmetallic, corrosion-resistant material with the same or better chemical compatibility properties as the HDPE pipe. Spacer intervals and attachment method to the carrier pipe shall be in accordance with the manufacturer's recommendations. Spacing shall be reduced if required to maintain the annulus between the carrier and containment pipes and shall be positioned to allow for unrestricted passage of possible flow of fluid from the carrier pipe. Spacers shall be chamfered at both ends to allow for removal of carrier pipe. Materials and systems used to secure the spacers to the pipe shall have the same or better chemical compatibility properties as the HDPE pipe.

Fittings: Fittings shall conform to the requirements of Article HDPE PIPE of this section and shall be compatible with components of the single wall HDPE pipe where required (except for trench riser pipes).

SLOTTED PIPE:

Leachate Collection Piping: Leachate collection and leak detection piping on the floor of the cells and elsewhere as shown on the Drawings shall be slotted. Cleanout access pipes and leachate transmission piping shall not be slotted.

In addition to meeting all other requirements of this section, slotted pipe shall have slots 0.128 inch wide and 1.25 inches long, in five places equidistant around the pipe for 12-inch and 18-inch diameter pipes. Slots shall provide a minimum of 9 square inches of open area per linear foot of pipe for 12-inch and 18-inch diameter pipes. For 3-inch diameter slotted pipe, the pipe supplier shall propose a configuration of 0.128-inch wide slots that provides a maximum of 7 square inches of open area per linear foot of pipe. Slotted pipes shall be free of cutting debris from the slot cutting process.

Perforated pipe with circular drill holes is not allowed.

PART 3 – EXECUTION

GENERAL:

All HDPE pipe and fittings shall be installed in conformance with applicable code requirements referenced in Section 15060, PIPING-GENERAL.

DIMENSIONS:

Piping dimensions shown on the Drawings are approximate. It is the Construction General Contractor's responsibility to furnish and install piping of the proper dimensions, which will properly fit with the connecting elements, pipes, fittings, pumps, etc.

INSTALLATION:

Pipe shall be handled and stored in such a manner as to ensure a sound, undamaged condition.

Pipe shall be cut in a neat, workmanlike manner using a mechanical cutter that will not damage the pipe.

Joining of HDPE pipe to HDPE pipe shall be accomplished by thermal butt fusion joint; no solvent welding or adhesive welding shall be allowed. Electrofusion couplings shall only be allowed when access to piping is restricted and only as approved by the Engineer. Slotted leachate collection piping shall be joined with thermal butt fusion joints. Pipe shall be joined per ASTM D2657 and manufacturer's recommendations.

Single butt fusion welds shall be used to create pipe sections as long as practicable. Fabricated pipe sections and fittings may be joined by the double butt fusion process.

During installation, the pipe shall not be pulled across sharp projections that could cause gouges, kinks, or other types of damage. To minimize "snaking" due to thermal expansion, protect pipe from direct sunlight, or limit unrestrained length of pipe during installation.

Allowance for Thermal Expansion/Contraction:

HDPE has a coefficient of thermal expansion of 1.2 x 10-4 ft/ft/deg F. Buried HDPE pipe shall be installed with excess length between anchor points such that contraction caused by temperature drop to 40 degrees F will produce the length of pipe between two points shown on the Drawings. Amount of excess pipe depends on temperatures of pipe at the time of installation, according to Table 1 for buried piping:

TABLE 1

Installation Temperature (degrees F)	Excess Pipe Length (in./100 ft)
50	1.4
60	2.9
70	4.3
80	5.8
90	7.2
100	8.6
120	11.5

Installation temperature is of the pipe material and not ambient air temperature. Measure installation temperature with a strip thermometer laid directly on the pipe. Verify temperate and excess pipe length required immediately before burial.

Placement of Buried Pipes:

Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.

The pipe shall not be dropped into the trench. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe. The full length of the pipe shall be firmly bedded on the trench bottom.

The pipe shall be bedded in such a way as to maintain grade with a tolerance of -0.0 percent, +0.5 percent with a uniform, constant grade and no localized low spots.

Pipe Base and Pipe Zone: As specified in Section 02320, TRENCH BACKFILL.

Keep trench dry until pipe laying and joining are completed.

Prevent foreign material from entering pipe during placement.

Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.

After joint has been made, check pipe alignment and grade.

Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

Prevent uplift and floating of pipe prior to backfilling.

Place pipe along pipe runs starting at one end and moving towards the other to avoid joints that will not be feasible with butt fusion.

Tolerances:

Horizontal position of pipe centerline on alignment around curves maximum variation of 1.0 foot from position shown.

Pipe Cover: Minimum 2 feet 6 inches from finished elevation of overlying material, unless otherwise shown.

Temporarily close pipe ends as required to avoid introducing dirt or other foreign material into the pipe.

Trenching and backfilling operations shall be conducted in accordance with the requirements of Section 02320, TRENCH BACKFILL, for utility trenching. If trenching is used, underlying materials shall not be disturbed or damaged in anyway. Backfilling operations shall ensure that no voids are present under or at the sides of the pipe. Backfill shall initially be placed to the top of the pipe, then hand compacted. The remainder of the trench shall then be backfilled and compacted by hand or with a power tamper only.

On the floor of the cell, pipe may be placed directly on geosynthetic layers prior to placing drainage gravel. Placement of gravel around pipes shall be by hand unless otherwise approved by the Engineer. Placement operations shall ensure that no voids are present under or at the sides of the pipe. Placement operations shall not disturb the position of the pipe.

Where flanged joints are used, the bolts shall be evenly torqued using a crossing pattern to gradually tighten the lug nuts. Torque values shall be as recommended by the flange manufacturer. Flanged joints shall be retorqued after one hour or more has passed. Apply anti-seize compound on all threaded surfaces before tightening.

Flaws (minor imperfections, damaged areas, etc.) in HDPE pipe with a depth of 10 percent or less of the nominal wall thickness will not require repair or replacement. In double containment systems, carrier pipe with flaws deeper than 10 percent of the wall thickness shall be replaced. Single pipe or containment pipe with flaws between 10 and 25 percent of the wall thickness shall be repaired in accordance with the pipe manufacturer's recommendations. The Construction General Contractor shall certify in writing that the repaired area will have material properties that meet or exceed those of intact pipe. Any pipe with flaws deeper than 25 percent of the nominal wall thickness shall be rejected.

All valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

Butt-fusion shall be performed in accordance with pipe manufacturer's recommendations as to equipment and technique.

Weld Beads: Remove internal weld beads from the side slope risers and horizontal sections of slotted pipe where the LCRS and LDS pumps will be placed and the horizontal and vertical sections of the LCRS level transducer pipe. Remove all plastic debris from inside pipe.

Slotted Pipe. Slotted pipe shall be cut and joined so that full contact is made around the entire circumference of the weld. Partial weld contact because of joints through a slot row is not acceptable.

LOCATOR RIBBON:

Locator ribbon shall be installed as specified in Section 02320, TRENCH BACKFILL.

IDENTIFICATION RIBBON:

Underground pipelines, except for pipelines inside the Phase I liner limits, shall be identified by use of a plastic ribbon or stencil no less than 3 inches in width with a message printed on the ribbon, which identifies the actual pipeline contents. Marking tapes or stencils shall be placed on existing lines where they are exposed by trenching operations. The ribbon shall be wrapped around the pipeline at no less than 1 wrap per 3 feet of run. The plastic ribbon/stencil shall be color coded in accordance with the Piping Schedule.

CLEANING:

Clean all piping as required in Section 15060, PIPING-GENERAL, to remove all foreign materials including dirt, grease, and other matter.

CONSTRUCTION QUALITY CONTROL (ACCEPTANCE TESTING):

Per Section 15992, PIPING LEAKAGE TESTING, and the Piping Schedule in Section 15060, PIPING-GENERAL.

END OF SECTION 15021

1 Attachment 1, High Density Polyethylene (HDPE) Pipe

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
Pipe		Pipe SDR shall be AS INDICATED ON THE Piping Schedule in Section 15060, PIPING-GENERAL.
		Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin.
		Pipe wall thickness shall reflect the required SDR* and diameter, as shown in Table 8, ASTM F714.
		*SDR: standard dimension ratio = OD/thickness
Fittings	6-inch and smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
	8-inch and larger	Molded if manufactured as a standard item or same as pipe, butt fusion joined, conforming to ASTM D3350.
Electrofusion Couplers		Rigid, straight coupler constructed from injection-molded polyethylene with embedded heating coils as manufactured by Central Plastics; or equivalent.
Flanges		ASTM A351 Type 316/CF8M stainless steel, 150-pound, ANSI B16.5 standard, convoluted back-up ring with one-piece polyethylene molded flange adaptor ends, same rating pressure as pipe.
Bolting		Stainless steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts.
		Manufacturer's recommended anti-seize compound on all threads.
		Washers shall be same material as bolts.
Gaskets		Flat ring, 1/8-inch Viton.

SECTION 15022 – HIGH DENSITY POLYETHYLENE MANHOLES Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials.

ASTM D3350 Specification for Polyethylene Plastics Pipe and Fitting Materials.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Product data sheets for make and model.

Complete catalog information, descriptive literature, specifications, construction drawings, and identification of materials of construction.

Provide calculations indicating diameter and wall thickness of each manhole is acceptable per design criteria specified.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Submit results of manhole leakage testing.

PART 2 – PRODUCTS

HDPE MANHOLES:

The manhole shall be manufactured by the fabrication of high density polyethylene (HDPE pipe). The riser shall be made of HDPE plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D1248. The cell classification shall be 345434C per ASTM D3350. Alternate cell classifications are acceptable if one or more of the six numbers in the cell classification are greater than the minimum. Pipe shall be rated PE3408.

Flatstock shall meet or exceed ASTM D1248 requirements for Type III, Class C, Category 3, Grade G5.

HDPE pipe and flatstock used to fabricate the HDPE manhole shall meet all product requirements of Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE. HDPE pipe for 76-inch diameter manhole shall be SIDR 39.0. HDPE pipe for 42-inch diameter manhole shall be SDR 21.

Welding rods, connecting couplings, pipe collars and other materials, as required to complete the installation, shall be of the same plastic as the flatstock.

Piping and appurtenances shall meet the requirements of Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and Section 15060, PIPING–GENERAL.

Access hatch shall be precast vault lid with spring-assisted galvanized plate cover with locking latch; cover shall be weather tight with channel drain. Utility Vault Model 77-2-332P; or approved equal.

Wall thickness and diameter of each manhole shall be verified assuming the following design criteria: Dimensions specified and depth of manholes identified on Drawings.

Lateral load transmitted to 76-inch diameter manhole from concrete ring footing shown on Drawing H-2-830850.

Weight of precast utility vault equal to 4,020 pounds.
Load on utility vault equal to 100 pounds per square foot (vault will not have traffic loads).
No groundwater forces acting on 76-inch diameter manhole.
42-inch manhole full of water.

PART 3 – EXECUTION

FABRICATION:

Inlet and outlet piping shall be installed as shown on Drawings by fabricator prior to delivery to site.

The manhole shall be fabricated with the minimum number of welds practical.

All welds shall be heat fused in accordance with manufacturer's recommendations on equipment specifically designed for welding thermoplastic sheets or extrusion welded by precertified welders.

INSTALLATION:

Manholes shall be handled and stored according to manufacturer's recommendations and in such a manner as to ensure a sound undamaged condition.

Excavation and backfilling operations shall be conducted in accordance with Section 02316, EXCAVATION, and Section 02315, FILL AND BACKFILL.

Joining of HDPE field piping to HDPE manhole pipe stubouts shall be done by thermal butt or socket fusion, no solvent or adhesive welding shall be allowed. HDPE welding shall be by qualified and approved welders as identified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Install piping, appurtenances, and pipe hangers and supports in accordance with Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and Section 15060, PIPING-GENERAL.

Install access hatch in accordance with Drawings.

CONSTRUCTION QUALITY CONTROL – LEAKAGE TESTING

After all HDPE manhole pipe stubout connections have been completed for inner and outer HDPE manholes, and prior to backfilling, perform separate leakage tests for inner and outer manholes. Each manhole shall be completely filled with water and no leaking shall be allowed from any HDPE joints for a period of 8 hours. General Construction Contractor shall provide necessary shoring during leakage testing of outer manhole per manufacturer's recommendations to compensate for lack of backfill.

END OF SECTION 15022

SECTION 15060 – PIPING-GENERAL Sched. B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing leachate piping and associated components.

REFERENCES:

The following is a list of standards, which may be referenced in this section and any supplemental Data Sheets:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.3	Malleable Iron Threaded Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.11	Forged Fittings, Socket-Welding and Threaded
ANSI B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ANSI B16.42	Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B36.10M	Welded and Seamless Wrought Steel Pipe

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C153/ A21.53	Ductile-Iron Compact Fittings 3 Inches Through 24 Inches and 54 Inches Through 64 Inches, for Water Service

ASTM INTERNATIONAL (ASTM)

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM D1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2467	Standard Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product data sheets, complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.

Qualifications:

Solvent Welders: List of solvent welders and current test records for solvent welder(s) for field solvent welding.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Manufacturer's Certification of Compliance.

PART 2 – PRODUCTS

PIPING:

High Density Polyethylene Piping: As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

Others as specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

Diameters Shown:

Standardized Products: Nominal size.

Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.

JOINTS:

Flanged Joints:

Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.

Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.

Mechanical connections of high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of products as specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE, and bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.

GASKET LUBRICANT:

Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

DOUBLE WALL CONTAINMENT PIPING SYSTEM:

As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

FLEXIBLE HOSE:

Flexible hose required for connection of leachate pump discharge piping to crest pad piping manifold and at truck loading station shall be Royalflex, vinyl nitrile by Boston Industrial Products, or equal, rated at a minimum of 125 psi.

A male and female quick-connect coupling shall be factory or shop installed on each length of flexible hose with stainless steel banding. 1-1/2-inch quick connect couplings for flexible hose and leachate pump discharge piping within the slope riser pipe shall be fiberglass-filled polypropylene, 3-inch quick connect couplings shall be stainless steel, each size shall include stainless steel rings, arms, and pins. Stainless steel quick connects shall have minimum pressure rating of 150 psig. Anti galling compound shall be used for threaded stainless steel connections.

VENT AND DRAIN VALVES:

Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.

Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

FABRICATION:

Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer.

FINISHES:

Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

Galvanizing:

Hot-dip applied, meeting requirements of ASTM A153.

Electroplated zinc or cadmium plating is unacceptable.

Stainless steel components may be substituted where galvanizing is specified.

LOCATOR RIBBON:

As specified in Section 02320, TRENCH BACKFILL.

INSULATION:

Piping:

Combined Sump (Discharge Piping Only) and Piping Requiring Heat Trace:
Material: Flexible elastomeric pipe insulation, closed cell structure, 3/4 inch thick.
Temperature Rating: Minus 40 degrees F to 180 degrees F.
Nominal Density: 6 pcf.

Conductivity in accordance with ASHRAE 90.1 and minimum of 0.27 BTU-in/hr-ft2 degrees F at 75 degrees F per ASTM C177 or ASTM C518.

Minimum water vapor transmission of 0.10 perm-inch per ASTM E96.

Seal joints with manufacturer's adhesive.

Flame Spread Rating: Less than 25 per ASTM E84.
Manufacturers and Products:
Rubatex; R-180-FS.
Armstrong; Armaflex AP.
Piping and Insulation Cover: Aluminum jacket 0.016-inch thick.

PART 3 – EXECUTION

EXAMINATION:

Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

PREPARATION:

Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

INSTALLATION-GENERAL:

Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

Remove foreign objects prior to assembly and installation.

Flanged Joints:

Install perpendicular to pipe centerline.
Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
Threaded flanged joints must be shop fabricated and delivered to jobsite with flanges in-place and properly faced.

Threaded and Coupled Joints:

Conform with ANSI B1.20.1.
Produce sufficient thread length to ensure full engagement when screwed home in fittings.
Countersink pipe ends, ream and clean chips and burrs after threading.
Make connections with not more than three threads exposed.
Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.
High Density Polyethylene Piping: As specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

INSTALLATION-EXPOSED PIPING:

Piping Runs:

Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

Piping Clearance (unless otherwise shown):

Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet 0 inches, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

Head room in front of openings, doors, and windows shall not be less than the top of the opening.

Do not install piping containing liquids or liquid vapors in transformer vaults.

Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

INSTALLATION-DOUBLE WALL CONTAINMENT PIPING SYSTEM:

Install as specified in Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

INSTALLATION-BURIED PIPE:

Placement: In accordance with Section 15021, HIGH DENSITY POLYETHYLENE (HDPE) PIPE.

SLAB, FLOOR, WALL, AND ROOF PENETRATIONS:

Application and Installation: As shown on Drawings.

Wall Pipe Installation: Support wall pipes securely by framework to prevent contact with reinforcing steel and tie wires.

BRANCH CONNECTIONS:

Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

Threaded Pipe Tap Connections:

Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.

Limitations: Threaded taps in pipe barrel are unacceptable.

CLEANING:

Following assembly and testing, and prior to final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

The up-slope riser pipe and slotted pipe shall be cleaned internally after deburring by pulling cotton pillows attached to ropes through pipe repeatedly until no debris comes out of pipe with pillow. Water flushing shall not be permitted. Pipe ends shall be covered after fabrication and at the end of shifts to avoid foreign materials from entering pipe.

If impractical to flush large diameter pipe at 2.5 fps, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

FIELD FINISHING:

Notify Construction Manager at least 3 days prior to start of any surface preparation or coating application work.

LOCATOR RIBBON:

Locator ribbon shall be installed as specified in Section 02320, TRENCH BACKFILL.

PIPE IDENTIFICATION:

EXPOSED PIPING:

In general, all exposed piping shall be color coded and identified in accordance with ANSI A-13-1. It is the intent of this standard that the identification method of aboveground piping is by English text that allows the contents to be readily identified. Flow direction should be also shown by arrows.

All piping and equipment shall be identified in accordance with established site standards.

In addition to the requirements specified herein, all pipelines and standard equipment shall be color coded and identified with beaded chain or steel cable stainless steel tags displaying the pipe or equipment number as shown on the Drawings. The tags shall be fabricated from 300 series austenitic stainless steel metal strips 3/4 inch wide, 24-gauge minimum thickness, with 3/16-inch high letters stamped on the metal surface. Any pipes entering or leaving a building shall be tagged adjacent to floor or wall penetration. The tags shall be attached to the pipe or austenitic equipment with austenitic stainless steel bead chain or austenitic stainless steel cable. When tagging valves, the bead chain shall be attached to the valve stem or yoke.

CONSTRUCTION QUALITY CONTROL – LEAKAGE TESTING:

As specified in Section 15992, PIPING LEAKAGE TESTING.

SUPPLEMENTS:

Supplement 1—Polyvinyl Chloride (PVC) Pipe and Fittings.
Supplement 2—Galvanized Steel Pipe and Malleable Iron Fittings.
Supplement 3—Piping Schedule.

END OF SECTION 1506

Polyvinyl Chloride (PVC) Pipe & Fittings

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
		Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket-weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with 2 percent titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket-weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1 drilling
Bolting	All	ASTM A193/A193M Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/ A194M Grade 8M hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber.
		Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564.
Thread Lubricant	All	Teflon Tape.

Galvanized Steel Pipe & Malleable Iron Fittings

Item	Size	Description
Pipe		Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	2" and smaller	Schedule 80.
	2-1/2" through 6"	Schedule 40.
Joints	All	Threaded or flanged at valves and equipment.
Fittings		Threaded: 150- or 300-pound galvanized malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1/16-inch raised face.
Unions		Threaded malleable iron, ASTM A197 or A47, 300-pound WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Bolting		Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 1/8 inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2.
Thread Lubricant	2" & smaller	Teflon tape or joint compound that is insoluble in water.

Piping Schedule Legend

SERVICE CODE	
LH	Leachate Handling
LHCP	Leachate Handling Containment Pipe
LT	Leachate Transfer
LTCP	Leachate Transfer Containment Pipe
SERVICE	
CPB	Crest Pad Building
CS	Combined Sump
IC	In-Cell
LTB	Leachate Transfer Building
OC	Outside-Cell
TL	Truck Loading
EXPOSURE	
BUR	Buried
EXP	Exposed
SUB	Submerged
MATERIAL	
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene
PVC	Polyvinyl Chloride
PRESSURE TEST	
H	Hydrostatic
P	Pneumatic
NA	Not Applicable
JOINT TYPE	
BF	Butt Fused
FL	Flanged
SW	Solvent Weld
TH	Threaded
QC	Quick Connect

1 Piping Schedule

Service Code	Service	Size(s) (In.)	Exposure	Piping Material	Joint Type	Specification Section	Test Type	Test Pressure (psi)[1]	Remarks
LH	IC	All	BUR	HDPE	BF, QC	15021	H	65* LCRS–Low Flow 100* LCRS–High Flow 65* LDS	SDR 11
LHCP	IC	3”	BUR	HDPE	BF	15021	P	8	SDR 11, slotted portion of pipe not to be tested
LHCP	IC	12” & 18”	BUR	HDPE	BF	15021	P	8	SDR 17, slotted portion of pipe not to be tested
LH	CPB CS	All	EXP	PVC	SW, FL, TH	15060	H	75	SCHD 80
LH LT	OC	3”	BUR	HDPE	BF	15021	H	65, except 75 for LH-30 and LH-24	SDR 11
LH LT	OC	4”	BUR	HDPE	BF	15021	H	65	SDR 17
LHCP LTCP	OC	2”	BUR	HDPE	BF	15021	P	8	SDR 11 for all except SDR 9 for 219A(E)201-2”-LTCP-043-HDPE
LHCP LTCP	OC	6” & 8”	BUR	HDPE	BF	15021	P	8	SDR 17
LT	LTB	All	EXP	PVC	SW, FL, TH	15060	H	75	SCHD 80
LT	TL	All	EXP	GSP	FL, TH	15060	H	65, except 75 for LT-37	SCHD 40

*Test pressures measured at Crest Pad Building. Isolate any appurtenances not rated for test pressure such as vacuum breakers and pressure gages.

Notes: 1. Test pressures shown are for a minimum allowable pressure. Maximum test pressures cannot exceed pressure rating of the pipe during the expansion phase of the pressure test.

2

SECTION 15100 – VALVES, OPERATORS, AND FILTER Sched. A & B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing valves, filters, and associated components for leachate and raw water systems. Valves and accessories for raw water are identified as such. Other requirements apply to leachate and raw water systems.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C509	Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C550	Protective Epoxy Interior Coatings for Valves and Hydrants

ASTM INTERNATIONAL (ASTM)

ASTM A276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A351	Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts
ASTM B61	Standard Specification for Steam or Valve Bronze Castings
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B98	Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B127	Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
ASTM B139	Standard Specification for Phosphor Bronze Rod, Bar, and Shapes
ASTM B164	Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B194	Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D429	Test Methods for Rubber Property—Adhesion to Rigid Substrates
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Product data sheets for make and model.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Manufacturer's Certificate of Compliance for butterfly valves; full compliance with AWWA C504.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Documentation of construction quality control testing as specified herein.

PART 2 – PRODUCTS

GENERAL:

Valve to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

Valve same size as adjoining pipe.

Valve ends to suit adjacent piping.

Size operator to operate valve for the full range of pressures and velocities.

Valve to open by turning counterclockwise.

Factory mount operator, actuator, and accessories.

Provide nametag for each valve. Nametag shall include valve tag number and be constructed of 16-Gauge Type 304 stainless steel, letters shall be 3/16-inch imposed, affix to valve with 16- or 18- gauge stainless steel wire.

MATERIALS:

Brass and bronze valve components and accessories that have surfaces in contact with liquids other than leachate to be alloys containing less than 16 percent zinc and 2 percent aluminum. Valves in service on leachate lines shall have no bronze, brass, or copper wetted parts.

Approved alloys are of the following ASTM designations:

B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

Stainless steel Alloy 18-8 may be substituted for bronze.

FACTORY FINISHING:

Exposed Valves:

Manufacturer's standard corrosion-resistant coating suitable for intended service.

Safety isolation valves and lockout valves with handles, hand wheels, or chain wheels "safety yellow."

Epoxy Lining and Coating:

Use where specified for individual valves described herein.

In accordance with AWWA C550 unless otherwise specified.

Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.

Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

VALVES:

BALL VALVES:

Type V330 PVC Ball Valve 2 Inches and Smaller: Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

Manufacturers and Products:

Nibco; True-Bloc.
ASAHI America; Duo-Bloc.
Or approved equal.

Type V331 PVC Ball Valve 3 and 4 Inches: Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 polyvinyl chloride full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ANSI B16.1.

Manufacturers and Products:

Nibco.
ASAHI America.
Or approved equal.

PVC 3-Way Ball Valve 2 Inches and Larger: Valves shall be three-way type with port option necessary to either direct flow through leachate filter or bypass flow around leachate filter. Valve configuration shall allow filter replacement simultaneously with flow through filter bypass. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, double union design, solvent weld socket ends, or flanged ends drilled to ASME B 16.5, Class 150, elastomer seat, Viton or Teflon O-ring stem seals, full ported ball.

Manufacturers and Products:

Spears; True Union 2000.
Or approved equal.

Check and Flap Valve:

Type V609 PVC Self-Closing Check Valve 3 Inches and Smaller: ASTM D1784, Type I, Grade 1, PVC body, rated at 150 psi, Viton seats and seals, stainless steel spring.

Manufacturer and Product: PLAST-O-MATIC; Series CKS.

PVC Swing Check Valve 4 Inch and Larger:
PVC body, flanged, rated at 150 psi at 70 degrees F minimum, EPDM elastomer seal.
Manufacturers and Product:
Hayward Model 5167.040

Self-Contained Automatic Valves:

Air Release Valve 1/2 Inch to 16 Inches:

1/2-inch through 3-inch NPT inlets and outlets, 4 inch and larger ANSI B16.1 flanged inlet with plain outlet and protective hoods.

Rated 150 psi working pressure, PVC body, EPDM seals.

Manufacturer and Product: IPEX; Series VAFV.

Vacuum Breaker Valve: 1/2-inch NPT inlet and outlet, PVC body, EPDM diaphragm, working pressure 100 psi.

Manufacturer and Product: PLAST-O-MATIC; Series VBM.

Gate Valves:

Type V100 Gate Valve 3 Inches and Smaller (Raw Water): All-bronze, screwed bonnet, single solid wedge gate, nonrising stem, rated 125-pound SWP, 200-pound WOG.

Manufacturers and Products:

Stockham; B103, threaded end.

Crane; 438, threaded end.

Type V130 Resilient Seated Gate Valve, 2 Inches to 12 Inches (Combined Sump and Truck Loading Station):

Iron body, resilient seat, bronze mounted, ANSI Class 125 flanged ends, nonrising stem in accordance with AWWA C509, design working water pressure 200 psig for 2 inches through 12 inches, full port, fusion-epoxy coated inside and outside per AWWA C550.

Provide 2-inch operating nut and operator extensions for the gate valves on the secondary containment piping that drains into the combined sump. Provide handwheel operators for the gate valves at the truck loading station.

Manufacturers and Products:

M&H Valve; AWWA C509.
U.S. Pipe; Metroseal.

Type V130 Resilient Seated Gate Valve, 4 Inches to 12 Inches (Raw Water):

Iron body, resilient seat, bronze mounted, ANSI Class 125 flanged ends, nonrising stem in accordance with AWWA C509, design working water pressure 200 psig for 2 inches through 12 inches, full port, fusion-epoxy coated inside and outside per AWWA C550.

Provide post indicating assembly with detachable crank handle for 12-inch gate valve at raw water tie-in.

Manufacturers and Products:

U.S. Pipe; Metroseal.
Clow Corp; Model F-61XX.

Butterfly Valves:

General: Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:

Suitable for throttling operations and infrequent operation after periods of inactivity.

Elastomer seats, which are bonded or vulcanized to the body, shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.

Bubble-tight with rated pressure applied from either side.

No travel stops for disc on interior of body.

Self-adjusting V-type or O-ring shaft seals.

Isolate metal-to-metal thrust bearing surfaces from flowstream.

Valve actuators to meet the requirements of AWWA C504.

Type V530 Butterfly Valve 4 Inches to 24 Inches for Fire Protection Service (Raw Water):

UL Listed and FM Approved, flanged style, AWWA C504 Class 150B valve with cast iron body, aluminum-bronze disc, stainless steel stem, EPDM seat, geared operator with highly visible position indicator and detachable crank handle.

For buried service, provide post indicating assembly with detachable crank handle.

Manufacturers and Product: Pratt; PIVA.

Miscellaneous Valves:

Type V930 Fire Hydrant (Raw Water):

Hydrants shall be dry-barrel type conforming to AWWA C502 with valve opening at least 5 inches in diameter and designed so that the flange at the main valve seat can be removed with the main valve seat apparatus remaining intact, closed, and reasonably tight against leakage and with a breakable valve rod coupling and breakable flange connections located no more than 8 inches above the ground grade. Hydrants shall have a 6-inch bell connection, two 2-1/2-inch hose connections, and one 4-1/2-inch pumper connection. Outlets shall have American National Standard fire-hose coupling threads. Working parts shall be bronze. Design, material, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of red iron oxide, zinc oxide primer conforming to SSPC Paint 25, and two finish coats of silicone alkyd paint conforming to SSPC Paint 21; color shall be safety yellow. Caps and chains shall be furnished.

Manufacturers and Products: Clow Medallion.

Type V931 Yard Hydrant (Raw Water):

Non-freeze yard hydrant with 3/4-inch hose connection. Constructed of manufacturer's standard materials, rated for minimum pressure of 125 psi.

Manufacturers and Products: Wade 8610; or equal.

ACCESSORIES:

Operating Wrenches (Raw Water):

Two each T-handled galvanized operating wrenches for 2-inch square nut operator, 6 feet long.

Manufacturers and Products:

Mueller; No. A-24610.
Clow No.; F-2520.
Two each T-handled galvanized forked operating keys for cross handled valves, 7 feet long.

Cast Iron Valve Box (Raw Water): Designed for traffic loads, sliding type, with minimum of 6-inch ID shaft.

Box: Cast iron with minimum depth of 9 inches.

Lid: Cast iron, minimum depth 3 inches, marked WATER.

Extensions: Cast iron.

OPERATORS:

Manual Operator:

General:

Operator force not to exceed 40 pounds under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 40 pounds.

Operator self-locking type or equipped with self-locking device.

Position indicator on quarter-turn valves.

Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.

Exposed Operator:

Galvanized and painted hand wheels.

Lever operators allowed on quarter-turn valves 8 inches and smaller.

Valve handles to take a padlock, and wheels a chain and padlock.

Buried Operator:

Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.

Buried valves shall have extension stems, bonnets, and valve boxes.

LEACHATE FILTERS:

Stainless steel filter housings rated for 150 psi minimum at 120 degrees F and 160 gpm shall be installed as shown on the piping details. Each filter housing shall be installed with (12) 5 micron filter cartridges, each cartridge shall be 40 inches long. The filter housing shall have a mill finish and include installation of a vent valve with drain tubing, drain valves with drain tubing, and filter housing stand. The filter assembly shall have no more than a 10 psi pressure drop across the housing and clean filter cartridges when operating at 160 gpm of water flow. The filter inlet and outlets shall be ASME B16.5, Class 150 flanges. Furnish and install filter cartridges within filter housing, in addition provide a minimum of 72 additional filter cartridges for future filter changeouts.

The filter assembly shall include a wall mounted differential pressure indicator. The differential pressure indicator shall tie-in to the filter housing drain ports. The differential pressure indicator shall include a resettable drag pointer for indication of maximum differential pressure achieved, 4.5-inch dial, and a range of 0-15 psid.

Copper tubing shall be used for differential pressure indicator. Tubing shall be 1/4-inch seamless copper tubing conforming to ASTM B75. Wall thickness, diameter tolerances, and compression type brass fittings shall be in accordance with ASTM B251.

Manufacturers and Products:

Filter Assembly: GE Osmonics; NDV Series w/Hytrex Filter Cartridges (5 micron, 40-inch length).

Differential Pressure Indicator: Wika; 700.05.

PART 3 – EXECUTION

INSTALLATION:

Flange Ends:

Flanged valve boltholes shall straddle vertical centerline of pipe.

Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly; do not over tighten.

Screwed Ends:

Clean threads by wire brushing or swabbing.

Apply joint compound.

Valve Orientation:

Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.

Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above finish floor, unless otherwise shown.

Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

CONSTRUCTION QUALITY CONTROL:

Valves shall be tested prior to leak testing pipelines.

Construction General Contractor shall perform test that valves open and close smoothly.

Construction General Contractor shall count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.

END OF SECTION 15100

SECTION 15140 – PIPING SUPPORT SYSTEMS Sched. B

PART 1 – GENERAL

SUMMARY:

This section is for furnishing and installing leachate piping support systems.

REFERENCES:

The following is a list of standards, which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM A525 Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

BUILDING OFFICIALS AND CODE ADMINISTRATORS (BOCA)

Basic Building Code

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

Uniform Building Code

MANUFACTURERS' STANDARDIZATION SOCIETY (MSS)

SP 58 Pipe Hangers and Supports-Materials, Design and Manufacture

SP 69 Pipe Hangers and Supports-Selection and Application

SP 89 Pipe Hangers and Supports-Fabrication and Installation

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Drawings of each piping support system to scale shown, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and shop drawing detail number.

Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

DEFINITIONS:

Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.

Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

DESIGN REQUIREMENTS:

General:

Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89.

Pipe Support Systems:

Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation.

Seismic Load: Seismic performance category forces with seismic loads in accordance with local codes.

Safety Factor: Minimum of 5.

Maximum Support Spacing and Minimum Rod Size:

Steel or Ductile Iron Piping:

Maximum Support/ Pipe Size	Minimum Rod Size Hanger Spacing	Single Rod Hangers
1-inch and smaller	6 feet	1/4-inch
1-1/2-inch thru 2-1/2-inch	8 feet	1/4-inch
3-inch and 4-inch	10 feet	3/8-inch

Plastic and Fiberglass Piping:

Maximum Support Spacing: As recommended by manufacturer for flow temperature in pipe. Pipe insulation shall be included in the selection of maximum pipe support spacing.

Minimum Hanger Rod Sizing: Same as listed for steel pipe.

Framing Support System:

Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.

Column Members: Size in accordance with manufacturer's recommended method.

Support Loads: Calculate using weight of pipes filled with water.

Maximum Spans:

Steel and Ductile Iron Pipe, 3-Inch Diameter and Larger: 10-foot centers, unless otherwise shown.

Other Pipelines and Special Situations: May require supplementary hangers and supports.

Electrical Conduit Support: Include in design of framing support system.

Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

Vertical Sway Bracing: 10-foot maximum centers, or as shown.

PART 2 – PRODUCTS

GENERAL:

When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

Materials:

Wetted and Submerged: Stainless steel.

Atmospheric Exposed: Galvanized or painted steel.

HANGERS:

Clevis Type: MSS SP 58, Type 1 or 6.

Grinnell; Figure 104 or 260.

B-Line; Figure B3198 or B3100.

Hinged Split-Ring Pipe Clamp: MSS SP 58, Type 6 or 12.

Grinnell; Figure 104.

B-Line; Figure B3198H.

Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

Attachments:

I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, 28, 29, or 30, which engage both sides of flange.

Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

SADDLE SUPPORTS:

Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

Nonadjustable Saddle: MSS SP 58, Type 37 with U-bolt.

Grinnell; Figure 259.

B-Line; Figure B3090.

Adjustable Saddle: MSS SP 58, Type 38 without clamp.

Grinnell; Figure 264.

B-Line; Figure B3093.

WALL BRACKETS:

Welded Steel Bracket: MSS SP 58, Type 33 (heavy-duty).

Grinnell; Figure 199.

B-Line; Figure B3607.

One-Hole Clamp: Grinnell; Figure 126.

Channel Type:

Unistrut.
Kin-Line.

PIPE CLAMPS:

Riser Clamp: MSS SP 58, Type 8.
Grinnell; Figure 261.
B-Line; Figure B3373 or approved equal.

CHANNEL TYPE SUPPORT SYSTEMS:

Material:

Galvanized: Pre-galvanized in accordance with ASTM A525, Class G90, or hot-dip galvanized after fabrication.

Stainless Steel: Type 304 stainless steel.

Channel Size: 12-gauge, 1-5/8-inch wide series minimum.

Members and Connections: Design for all loads with safety factor of 5.

Manufacturers and Products:

Kin-Line; Series CI3812.

Unistrut; Series P3200.

B-Line; B2000 Series, or approved equal.

ANCHORING SYSTEMS:

Material:

Wetted and Submerged: Stainless steel.

Atmospheric Exposed: Galvanized.

Size: Sized by equipment manufacturer, 1/2-inch minimum diameter.

SHOP/FACTORY FINISHING:

Prepare, prime, and finish coat in accordance with:
Surface preparation with abrasive blast or centrifugal wheel blast (SP10).
Paint with:
One coat, 2.5 minimum dry film thickness (MDFT) of Epolon rust inhibitor primer.
One coat, 2.5 MDFT Epolon Multi-Mill Epoxy.
One coat, 1.5 MDFT Acrolon II, No. 2200 Series.

PART 3 – EXECUTION

INSTALLATION:

General:

Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.

Support piping connections to equipment by pipe support and not by the equipment.

Support large or heavy valves, fittings, and appurtenances independently of connected piping.

Support no pipe from the pipe above it.

Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

Install lateral supports for seismic loads at all changes in direction.

Repair mounting surfaces to original condition after attachments are made.

Standard Pipe Supports:

Horizontal Suspended Piping:

Single Pipes: Adjustable swivel-ring, splint-ring, or clevis hangers.

Grouped Pipes: Trapeze hanger systems.

Furnish galvanized steel protection shield and oversized hangers for all insulated pipe.

Furnish precut sections of rigid insulation with vapor barrier at hangers for all insulated pipe.

Horizontal Piping Supported From Walls:

Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

Stacked Piping:

Wall-mounted framing system and clips acceptable for piping smaller than 3-inch minimal diameter.

Piping clamps, which resist axial movement of pipe through support not acceptable.

Wall-mounted piping clips not acceptable for insulated piping.

Horizontal Piping Supported From Floors:

Stanchion Type:

Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

Use yoked saddles for piping whose centerline elevation is 18 inches or greater above the floor and for all exterior installations.

Floor Mounted Channel Supports:

Use for piping smaller than 3-inch nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

Attach channel framing to floors with anchor bolts.

Attach pipe to channel with clips or pipe clamps.

Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

Standard Attachments:

To Steel Beams: I-beam clamp or welded attachments.

To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

FIELD FINISHING:

Paint atmospheric exposed surfaces of black and hot-dip galvanized steel components as specified in Article SHOP/FACTORY FINISHING.

END OF SECTION 15140

SECTION 15500 – HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AIR MOVING AND CONDITIONING ASSOCIATION (AMCA)

AMCA 99	Air Movement and Control Association Standards Handbook
AMCA 210	Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	Reverberant Room Method for Sound Testing of Fans
AMCA 2401	Impeller Diameters and Outlet Areas for Centrifugal Fans and Metric Equivalents

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52	Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter
ASHRAE 90A	Energy Conservation in New Building Design

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1-	Motors and Generators

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

Guidelines for Seismic Restraints of Mechanical Systems
HVAC Testing, Adjusting, and Balancing Manual
UNDERWRITERS LABORATORIES INC. (UL)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics for the following products:

Air conditioning units.
Unit heaters.
Motorized dampers.
Complete performance data that indicate full compliance with the Specifications.
Recommended procedures for protection and handling of equipment and materials prior to installation.

Manufacturer's certification of factory testing to establish conformance with specified requirements for the unit heater and air conditioning unit.

For motors specified to be energy efficient type, certified copy of test report for identical motor tested, in accordance with NEMA MG 1-12.53a and IEEE Standard 112, Test Method B, showing full load efficiency.

Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

List of recommended spare parts for equipment and materials specified.

Manufacturer's warranty.

Operations and maintenance manuals including recommended preventative maintenance tasks and frequencies for performance of those tasks.

EXTRA MATERIALS:

Furnish, tag, and box for shipment and storage the following spare parts:

Filters: Four complete sets per unit.

SPECIAL GUARANTEE:

Manufacturer shall provide standard warranty.

PART 2 – PRODUCTS

GENERAL:

Heating Equipment: Minimum operating efficiencies as specified in Chapter 6 of ASHRAE Standard 90A, and the State of Washington Energy Code.

WALL-MOUNTED AIR-COOLED PACKAGED AIR CONDITIONING UNITS (FOR EQUIPMENT IDENTIFICATION NUMBERS SEE SUPPLEMENT):

General:

Packaged through-the-wall air conditioning unit.
Cooling section.
Heating section.
Controls.
Fans.
Filters.
All contained in a standard weatherproof enclosure.
UL listed.

Enclosure:

Zinc-coated steel finished with manufacturer's standard baked enamel paint.
Adjustable discharge grille.
Return grille.
Permanent filter.
Internal sound attenuation.
Controls with adjustable thermostat.
Fan speed switch with HIGH/LOW manual selections.

Heating Section:

Low-density electric heating elements.
Built-in overheat protection.

Cooling Section:

Hermetic compressor.
Air-cooled condenser coil.
Evaporator coil.
Drain pan with drain line connections.
Direct-drive evaporator.
Condenser fans.
Fan motors with integral overload protection.
Operating and safety controls.
Operating charges of refrigerant and oil.

Capacity (219A-LH-AC-001 and 219E-LH-AC-001): 600 cfm at fan medium speed, at 0.3 inch of water column static pressure, minimum outside air 100 cfm, cooling capacity 25,110 Btuh total, 17,530 Btuh sensible, 85/72 degrees F DB/WB entering air temperature, and 100 degrees F ambient, 208-volt, single-phase power supply, MCA17, breaker size 20 amps.

Capacity (219A1-LH-AC-002 and 219E1-LH-AC-002): 360 cfm at 0.3 inch of water column static pressure, minimum outside air 100 cfm, cooling capacity 11,840 Btuh total, 8,130 Btuh sensible, 85/72 degrees F DB/FB entering air temperature, and 100 degrees F ambient, 208-volt, single-phase power supply, MCA 8 amps, breaker 15 amps.

Manufacturers and Products:

Bard:

Model (219A-LH-AC-001 and 219E-LH-AC-001): WA241-A-00-EXXXXA.

Model (219A1-LH-AC-002 and 219E1-LH-AC-002): WA121-A-00-EXXXXJ.

Or approved equal.

ELECTRIC UNIT HEATER (FOR EQUIPMENT IDENTIFICATION NUMBERS SEE SUPPLEMENT):

General:

Heater shall be installed and wired in accordance with the manufacturer's recommendations.

Unit heater shall be UL listed.

Casing:

Fabricated of die-formed, heavy-gauge steel and finished in high gloss, baked enamel.
Supply air shall be drawn through a stamped louver periphery evenly across the heating element.
Discharge air shall be through an outward drawn Venturi.
Cabinet shall have adjustable discharge louvers.
Cabinet shall be furnished with an access door.
Wiring diagram shall be permanently attached to the inside at the access door.

Elements:

Elements shall be high mass, all steel tubular finned type, copper brazed.
Elements shall be centrally located and installed in fixed element banks.

Motor:

Motor shall be totally enclosed, all angle industrial rated.

Bearings shall be sealed and permanently lubricated.

Fan:

Fan blades shall be of the axial flow type.
Fan speed shall not exceed 1,600 rpm.

Wiring:

Unit heater shall be factory prewired.
Unit heater shall have balanced phases.
Unit heater shall be equipped with automatic reset thermal overload.

Controls: Wall-mounted thermostat.

Manufacturers and Products:

Capacity: 3.3 kW, 460 volts, three-phase, horizontal discharge.

Trane; UHEC-033DACA.

RELIEF LOUVER (FOR EQUIPMENT IDENTIFICATION NUMBERS SEE SUPPLEMENT):

Extruded aluminum frame.
Double drainable blades.
Bird screen.
Size: Louver size as shown on Drawings.

MANUFACTURER AND PRODUCT: RUSKIN; MODEL ELF 375DD.

DAMPER ACTUATOR (FOR EQUIPMENT IDENTIFICATION NUMBERS SEE SUPPLEMENT):

Line voltage actuator.
Spring return.
UL listed.
NEMA 2 housing.
60-inch-pound torque.

Sequence of Operation: Actuator shall be interlocked with an economizer. Actuator shall be energized when economizer is on, and shall be closed when economizer is off.

Manufacturer and Product: Belimo; NF120US, 120 volts, single-phase, less than 60 seconds return time.

SEQUENCE OF CONTROL:

Air Conditioning Units:

Air conditioning unit shall be started by the signal from wall-mounted thermostat if the room temperature rises above 85 degrees F.

Thermostat set point is 80 degrees F.

If the room temperature drops below 70 degrees F, the modulating type return, outside and exhaust air dampers will be adjusted to maintain room temperature.

When outside air temperature is between 50 degrees F and 65 degrees F, air conditioning unit will provide a free cooling.

Unit Heaters: Unit heater will be operating in the ON-OFF sequence to maintain 50 degrees F temperature.

PART 3 – EXECUTION

INSTALLATION:

Install equipment and systems in accordance with manufacturers' instructions.

Packaged Wall-Mounted Air Conditioning Units:

Mount unit in accordance with manufacturer's instructions.
Provide access for maintenance.
Seal watertight to wall.

Electric Unit Heater: Install in accordance with recommendations of NFPA 90A.

SUPPLEMENTS:

The supplement listed below, following "END OF SECTION," is a part of this Specification.
Equipment Identification Numbers.

END OF SECTION 15500

Equipment Identification Numbers

Location	Equipment Name	Equipment Number
Cell No. 1 Crest Pad Building	Air Conditioning Unit	219A-LH-AC-001
	Unit Heater	219A-LH-UH-001
	Relief Louver with Motorized Damper	219A-LH-MD-001
Cell No. 1 Leachate Transfer	Air Conditioning Unit	219A1-LH-AC-002
	Building Unit Heater	219A1-LH-UH-002
	Relief Louver with Motorized Damper	219A1-LH-MD-002
Cell No. 2 Crest Pad Building	Air Conditioning Unit	219E-LH-AC-001
	Unit Heater	219E-LH-UH-001
	Relief Louver with Motorized Damper	219E-LH-MD-001
Cell No. 2 Leachate Transfer	Air Conditioning Unit	219E1-LH-AC-002
	Building Unit Heater	219E1-LH-UH-002
	Relief Louver with Motorized Damper	219E1-LH-MD-002

SECTION 15992 – PIPING LEAKAGE TESTING

Sched. B

PART 1 – GENERAL

SUMMARY:

This section is for leak testing (construction quality control) leachate piping and associated components.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Testing Plan: Submit prior to testing and include at least the information that follows.

Testing dates.

Piping systems and section(s) to be tested.

Test type.

Method of isolation.

Sample of test report form.

Certifications of Calibration: Testing equipment.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Certified Test Report.

Provide Manufacturer's calibration recommendations and current calibrations of pressure gauge(s).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

PREPARATION:

Notify Construction Manager in writing 5 days in advance of testing. Perform testing in presence of Construction Manager.

Pressure Piping:

Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

Items that do not require testing include: Piping between wetwells and wetwell isolation valves, tank overflows to atmospheric vented drains, tank atmospheric vents, and slotted piping.

Test section may be filled with water and allowed to stand under low pressure prior to testing.

Other Piping:

Perform testing of other pipe service types using the same methods outlined for pressure piping.

HYDROSTATIC TEST:

General: Hydrostatic testing shall be performed on all single-wall pipe, inner carrier pipes, and all PVC piping.

Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

Test Pressure:

PER SECTION 15060, PIPING–GENERAL.

Exposed Piping:

Perform testing on installed piping prior to application of insulation.

Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.

Maximum Filling Velocity: 0.25 feet per second, applied over full area of pipe.

Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

HDPE PIPING:

Test Procedure: The test procedure consists of an initial expansion phase and then the test phase. Prior to the test procedure the test medium and pipe test section shall be allowed time to equalize in temperature. Testing shall not be allowed if temperatures of the test medium or pipe test section exceed 100 degrees F.

Maintain the test pressure for a period of 3 hours during the initial expansion phase by adding water as needed.

At the beginning of the test phase after the initial expansion phase, reduce pressure by 10 psi. Maintain this test pressure for a period of 1 hour.

Under no circumstances shall the testing be allowed to exceed 8 hours.

Acceptance Criteria: The test phase is passed and the pressure test is acceptable if the pressure remains steady (within 5 percent of the test phase beginning pressure) for 1 hour and there are no indications, visible or otherwise, of leakage.

If acceptance criteria is not met, any leakage points shall be fixed and any other changes made to the piping system as necessary. Retest and repeat until acceptance criteria is met.

Empty pipe of water prior to final cleaning.

Buried Piping: Test piping using the same procedure as outlined for exposed piping as described above.

PVC and Non-HDPE Piping:

Perform testing on installed piping prior to application of insulation.

Prior to pressure testing, check all manually operated valves for smooth operation and count and record number of turns to open and close each valve.

Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage. No fluid shall be added to the system, and system shall not drop below 95 percent of the test pressure during the test period.

Examine exposed joints and connections for leakage.

No loss of fluid allowed. Find any leakage points, fix, and retest as specified.

Empty pipe of water prior to final cleaning or disinfection.

PNEUMATIC TEST:

General: Pneumatic testing shall be performed for outer pipe of double-wall HDPE piping and atmospheric drains.

Double-Wall Pipe: Inner carrier pipe shall be full of water when outer containment pipe is tested to prevent damage to carrier pipe and riser pipes.

Equipment:

Gauges shall be calibrated within manufacturer's recommended frequency and calibration shall be current.

Install gauges, air piping manifolds, and valves at ground surface.

Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 10 psi or less.

Restrain plugs used to close lines to prevent blowoff.

Procedure:

Maintain test pressure for 10 to 60 minutes but not for more than 60 minutes.

Slowly introduce air into pipe section until internal air pressure reaches required test pressure. (A maximum 5% gauge loss is acceptable.)

Allow 2 minutes minimum for air temperature to stabilize.

Examine exposed joints and connections for leakage using liquid bubble tests or other method to determine source of leakage approved by the construction manager.

No loss in pressure allowed. Find any leakage points, fix, and retest as specified.

Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

END OF SECTION 15992

DIVISION 16 – ELECTRICAL

SECTION 16005 – ELECTRICAL

PART 1 – GENERAL

UL AND NRTL COMPLIANCE:

Materials manufactured within the scope of UL or another nationally recognized testing laboratory (NRTL) shall conform to UL or NRTL standards and have an applied UL or NRTL listing mark. References to UL throughout this section imply conformity with UL or NRTL standards and guidelines.

Electrical system process control panels shall be manufactured, assembled, tested, approved, and clearly labeled in accordance with UL 508A, prior to delivery to construction site.

APPROVAL BY AUTHORITY HAVING JURISDICTION (AHJ):

Provide all work in accordance with NFPA 70, National Electrical Code, ANSI C2 National Electrical Safety Code (NESC), and where required by Hanford CH2M HILL authority having jurisdiction (AHJ), as defined under Division 1, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to AHJ, in order to provide a basis for approval under NEC.

All material and equipment shall be tested after installation by a qualified testing firm (as specified in Section 16080, ELECTRICAL TESTING), or other organization acceptable to AHJ, in order to provide a basis for approval under NEC. Construction General Contractor is responsible for providing qualified testing firm and shall coordinate with the Construction Manager for NEC inspection services.

All material and equipment shall be provided with a visibly attached label by a nationally recognized testing laboratory or other organization acceptable to AHJ, prior to delivery to construction site.

All motor control panels shall be provided in accordance with UL 508 and with a visibly attached label by a nationally recognized testing laboratory or other organization acceptable to AHJ, prior to delivery to construction site.

All equipment shall be installed per manufacturer's instructions, with NFPA 70, NESC, and with other applicable requirements.

All electrical work including conduit, wiring, and terminal and splice connections shall be accomplished by a state-registered and approved electrical journeyman or a state-registered and approved electrical apprentice under supervision of state-registered and approved electrical journeyman.

ELECTRICAL DESCRIPTION OF WORK:

Schedule A Work:

Provide and install primary aerial cables, power poles, fuse-cutouts, supports, primary riser conductors, and ancillary equipment as needed to extend existing primary power circuit C8–L6 from 4th street to new IDF pad mount service transformer as shown on Drawings and in accordance with Section 16312, OVERHEAD ELECTRICAL DISTRIBUTION.

Provide and install IDF pad mount service transformer as shown on Drawings and in accordance with Section 16270, Oil-Filled Pad Mounted Transformer.

Provide site preparation, pad mount slab and concrete work, and grounding as necessary to facilitate utility vault and pad mount service transformer installation.

For primary (15kV) conductors, which route from riser pole fuse cut-outs to pad mount service transformer, reference CONDUCTOR OVER 600 VOLTS this Section.

Fluor Hanford Electrical Utilities will make final aerial conductor connections to existing primary circuit C8–L6, and primary connections to pad mount service transformer.

Coordinate installation of all primary service equipment, testing, and secondary metering with Construction Manager, who will contact Fluor Hanford Electrical Utilities (FH EU).

Schedule B Work:

Provide and install power conduits and cables to electrical service gear for each crest pad and leachate transfer building. Power conduits and cables shall route from crest pad building electrical service gear to power handhole(s) and service transformer as shown on Drawings.

FH EU will make final secondary conductor connections within low voltage compartment of pad mount service transformer after cables are routed under this schedule of work.

Coordinate with FH EU installation of secondary cables and energizing of secondary service equipment.

Provide and install communication conduits and cables for each crest pad and leachate transfer building communication service. Communication conduits and cables shall route below grade from crest pad building to communication handhole(s) as shown on Drawings.

Provide and install electrical service gear for each crest pad and leachate transfer building including: motor control center (MCC), MCC integrally mounted lighting panel and transformer, and grounding electrode system.

Motor control center shall provide 480V, three-phase, three-wire power to pump motors, power outlets, building heaters, air monitoring transformer and panel assemblies, and motor starters.

Lighting panel and transformer shall provide 208/120V, three-phase, four-wire power for instruments, lighting, receptacles, small motor loads, and miscellaneous panels.

Lighting panel and transformer(s) shall provide 120/240V, single-phase, three-wire power for air monitoring equipment and ancillary lighting and receptacles.

Provide and install grounding electrode system at each crest pad and leachate transfer building. Bond service gear, lighting transformer, power and communication panels, and metal structures (i.e., leachate storage tank, buildings) to grounding electrode system.

Provide and install power conduits and cables to the following three-phase equipment:

Building unit heaters.
Leachate collection and removal and leak detection system pumps.
Combined sump pumps.
Leachate transfer pumps.
Portable generator power outlets.

Provide and install power conduits and cables to the following single-phase equipment:

Building interior and exterior lighting.
Building receptacles.
Building control panels.
Building air conditioning units.
Heat tracing.
Air monitoring equipment.

Provide and install control and signal conduits and cables to the following instrumentation:

Process local control panels.
Building temperature transmitters.
Building sump level floats and panels.
Building ventilation thermostats.

Leachate collection and removal and leak detection system pump flow meters and submersible pressure transmitters.

Storage tank level transmitters and switches.

Leachate collection carrier pipe leak detection level switches, mounted in combined sumps' interstitial spaces.

Combined sump level floats.

Leachate transfer flow meters and transmitters.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Primary and secondary service entrance and metering equipment.
Boxes and device plates.
Junction and pullboxes.
Precast utility vaults, manholes and handholes.
Wiring devices.
Panelboards and mini-power centers.
Circuit breakers and switches.
Motor-rated switches.
Control devices, terminal blocks, and relays.
Contactors.
Transformers.
Support and framing channels.
Nameplates and nameplate schedule.
TVSS equipment.
Volt and current meters.
Conduit, fittings, and accessories.
Wireways.
Conductors, cable, and accessories.

Motors: Nameplate data, detailed information on any special features.

Grounding materials.

Motor Controls: Arrangement drawings, ratings, schematic and wiring diagrams, bill-of-materials, nameplate schedule, manufacturer information on components.

Local Control Panels: Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.

Luminaires.
Factory test reports.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Field test reports.

Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.

Operation and Maintenance Data:

Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance, in accordance with Division 1, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

ENVIRONMENTAL CONDITIONS:

Provide equipment and conduit systems approved for installing in the following environmental conditions:

Climatic and Geographic Site Conditions:

Site Elevation: 1,000 feet.

Relative Humidity: 90 percent maximum at 30 degrees F dry bulb, 15 percent minimum at 60 degrees F dry bulb.

Uniform Building Code: Seismic Zone 2B.

Temperature: 105 degrees F max. 0 degrees F min.

Enclosures and Environmental Conditions:

Provide and install NEMA 250 Type 4X, Type 304 stainless steel (corrosion resistant, wash down protection) enclosures in process mechanical and wash down indoor locations unless otherwise noted within this section.

Provide and install NEMA 250 Type 3 (dust, rain and ice protection) enclosures in outdoor locations unless otherwise noted in this section.

Provide NEMA 250 Type 12 (dust protection) enclosures for indoor dry protected locations unless otherwise noted in this section.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches.

PART 2 – PRODUCTS

GENERAL:

Products shall comply with all applicable provisions of NFPA 70.

Like Items of Equipment: End products of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's service.

Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature ranges identified under ENVIRONMENTAL CONDITIONS in this section.

Hazardous Areas: Products shall be acceptable to the regulatory authority having jurisdiction for the interior of the combined sumps. Class 1, Division 2, Groups C and D.

Equipment Finish: Manufacturer's standard finish color, except where specific color is indicated.

SERVICE ENTRANCE:

Coordinate all service entrance work with Construction Manager, who will in turn coordinate with Fluor Hanford Electrical Utilities, contact person: Cris Carlson, P.E., 509-521-2823.

UTILITY METERING:

Watt-hour Meter: Socket type, for three-phase, 4-wire wye service, self contained, with relay option board having output for watt KYZ pulses, 480 volt, class 200, form 16S, Elster alpha plus, type A1D+.

Meter Socket: Provide with manual circuit closing blocks, 7 terminal, 200 amp, 600 volt, Milbank type U3517-XL.

Meter Base Hub: Provide for standard RL opening, 2-inch, Milbank type A7517.

LIGHTING AND POWER DISTRIBUTION PANELBOARD:

NEMA PB 1, NFPA 70, and UL 67.

Panelboards and Circuit Breakers: Suitable for use with 75 degrees C copper wire at full NFPA 70, 75 degrees C ampacity.

Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

Rating: Applicable to a system with available short-circuit current of 10,000 amperes rms symmetrical at 208/120 volts and 120/240 volts.

Ground Fault Circuit Interrupter (GFCI): UL Class A GFCI, 5-mA trip, 10,000-amp interrupting capacity circuit breakers.

Ground Fault Equipment Protection (GFEP): 30-mA trip, 10,000-amp interrupting capacity circuit breaker, UL listed for equipment ground fault protection.

Interior Panelboard:

NEMA 250, Type 12 unless otherwise noted.

Material: Code-gauge, hot-dip galvanized sheet steel, with reinforced steel frame.

Wiring Gutter: Minimum 4 inches square; both sides, top and bottom.

Front: Fastened with adjustable clamps.

Interior:

Factory assembled; complete with circuit breakers.

Capable of circuit breaker replacement without disturbing adjacent circuit breakers or without removing main bus.

Spaces: Cover openings with easily removable metal cover.

Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

Bus Bar:

Material: Copper and/or tin-plated copper full sized throughout length.

Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

Neutral bus with at least two (neutral and ground) terminal screws for each circuit.

Note: Do not install multiwire branch circuits that share common neutral. Install neutral for each 120-volt branch circuit.

Lugs and Connection Points:

Suitable for copper conductors.
Solderless main lugs for main, neutral, and ground bus bars.
Bolt together and rigidly support bus bars and connection straps on molded insulators.

Circuit Breakers:

NEMA AB 1 and UL 489.

Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.

Noninterchangeable, in accordance with NFPA 70.

Locking: Provisions for handle padlocking, unless otherwise shown.

Type: Bolt-on circuit breakers in all panelboards.

Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.

Do not substitute single-pole circuit breakers with handle ties for multipole breakers.

Do not use tandem or dual circuit breakers in normal single-pole spaces.

Ground Fault Circuit Interrupter (GFCI):

Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5-mA ground fault (UL 943, Class A sensitivity).

Sensor with same rating as circuit breaker and a push-to-test button.

Manufacturers:

Square D
Cutler-Hammer
General Electric
Allen-Bradley

MINI-POWER CENTER (MPC):

General: Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, Type 3 enclosure.

Transformer:

Type: Dry, self-cooled, encapsulated.

Insulation: Manufacturer's standard, with UL 1561 temperature rise.

Full Capacity: 2-1/2 percent voltage taps, two above and two below normal voltage.

Primary Voltage: 480, three-phase; 480 single-phase as shown.

Secondary Voltage: 208/120 volts, three-phase, four-wire; 120/240 volts, single-phase, three-wire as shown.

Size: 7.5 kVA and 15 kVA as shown.

Panelboard: UL 489, fully rated.

Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.

Number and Breaker Ampere Ratings: Refer to Panelboard Schedule.

Manufacturers:

Square D Co.
Cutler-Hammer.
General Electric Co.

LIGHTING AND POWER DISTRIBUTION STEPDOWN TRANSFORMER (0-600 VOLTS):

Type: Self-cooled, two-winding.

UL 1561 and NEMA ST 20.

Insulation Class/Temperature Rise: 115 Degrees F.

Core and Coil:

30 kVA or Less: Encapsulated.

Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

Sound Level: Not to exceed NEMA ST 20 levels.

Vibration isolators to minimize and isolate sound transmission.

Manufacturers:

Square D
Cutler-Hammer/Westinghouse
General Electric.

LOCAL CONTROL PANELS:

Enclosure:

Reference ENVIRONMENTAL CONDITIONS in this section.

Minimum Metal Thickness: 14 gauge.

Doors: Rubber gasketed with continuous hinge.

Incandescent Light: Hand switch controlled, 100-watt.

Receptacle: Breaker protected 120-volt, 15-amp duplex.

Finish: Internal and external surfaces (NEMA 250, Type 12 only):

Sand panel; remove mill scale, rust, grease, and oil.
Fill imperfections and sand smooth.
Paint with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
Sand surfaces lightly between coats.

Final Dry Film Thickness: Minimum 3 mils.

Size panels to adequately dissipate heat generated by equipment mounted in or on panel.

Manufacturers:

Hoffman.

H. F. Cox.

Wiring:

Power and Control Wiring: 600-volt class, insulated, stranded copper.

Size: Minimum No. 14 AWG enclosed in either sheet metal raceway or plastic wiring duct.

Signal Circuit Wiring: Twisted shielded pairs minimum No. 16 AWG, separated at least 6 inches from power wiring.

Identification: Permanent heat impregnated polyvinyl chloride (PVC) alpha-numeric labels.

SAFETY SWITCHES:

UL 98 listed for use and location of installation.

Type: Visible blade, fusible.

Class: Heavy-duty.

Enclosures: Reference ENVIRONMENTAL CONDITIONS in this section.

CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS:

UL 489 listed for use at location of installation.

Minimum Interrupt Rating: As shown.

Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of operating handle.

Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

Locking: Provisions for padlocking handle.

Enclosure: Reference ENVIRONMENTAL CONDITIONS in this section.

Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

Manufacturers:

Square D Co.
Cutler-Hammer.
General Electric Co.
Allen-Bradley.

FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS:

UL 98 listed for use and location of installation.

NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current as shown.

Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.

Enclosure: Reference ENVIRONMENTAL CONDITIONS in this section.

Interlock: Enclosure and switch to prevent opening cover with switch in ON position.

Manufacturers:

Square D Co.
Cutler-Hammer.
General Electric Co.

FUSE, 0 TO 600 VOLTS:

Current-limiting, with 42,000 max ampere rms interrupting rating.
Provide to fit mountings specified with switches and features to reject Class H fuses.

Motor and Transformer Circuits, 0 to 600 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann; Type LPS-RK.

Littelfuse, Inc.; Type LLS-RK.

Motor and Transformer Circuits, 0 to 250 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann; Type LPN-RK.

Littelfuse, Inc.; Type LLN-RK.

Feeder and Service Circuits, 0 to 600 Volts:

Amperage: 0 to 600.

UL 198E, Class RK-1, dual element, with time delay.

Manufacturers and Products:

Bussmann; Type LPS-RK.

Littelfuse, Inc.; Type LLS-RK.

MAGNETIC CONTROL RELAYS:

NEMA ICS 2, Class A600 (600 volts, 10 amperes continuous, 7,200VA make, 720VA break), machine tool type with field convertible contacts.

Smaller Magnetic Control Relays: Reference Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS).

TIME DELAY RELAY:

Industrial Relay Rated: 150 volts, 5 amps continuous, (3600 VA make, 360 VA break).

Solid-state electronic, field convertible ON/OFF delay.
Two Form-C contacts (minimum).
Repeat accuracy plus or minus 2 percent.

Timer Adjustment: Multiple adjustable ranges, including 1 to 60 seconds, unless otherwise shown.

Manufacturers:

Omron.
Cutler-Hammer.
General Electric Co.
Allen-Bradley.

ELAPSED TIME METERS:

Type: Synchronous motor driven, 0 to 99,999.9 hours range, nonreset, suitable for semiflush, panel mounting.

Manufacturers:

General Electric Co.
Veeder-Root.

PHASE MONITOR RELAY:

Voltage and phase monitor relay shall drop out on loss of phase, or phase reversal.

Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.

Adjustable trip and time delay settings.

Transient Protection: 1,000V ac.

Mounting: Multipin plug-in socket base.

Accessories: Provide properly sized and rated line isolating switches and fuses for each phase monitored.

Manufacturer:

Square D Co.
Cutler-Hammer.
General Electric Co.
Allen-Bradley.

TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS) EQUIPMENT:

General:

Units shall be suitable for the service voltage and configuration (phases and wires) shown.

Protection Modes:

Normal, differential, and common.
Bipolar or bi-directional.

Ratings: Short-circuit current rating shall equal or exceed that of protected distribution equipment. Surge Voltage Rating (SVR) shall not exceed those specified under UL 1449 for the associated nominal system voltage. Maximum Allowable Continuous Operating Voltage (MCOV) shall be at least 115 percent of the nominal system voltage.

Unit shall be UL-listed.

Provide status indicators for unit ON-LINE and unit operation NORMAL.

Provide common alarm contact output.

Provide fusible disconnect switch (integral with TVSS unit, where available) where not shown connected via branch circuit device of protected distribution equipment.

Minimum Enclosure Rating: NEMA 250, Type 12.

Type 2 TVSS:

Requirements: Designed for critical loads at service equipment (Category C3/B3) or distribution panelboard (Category C2/B3) locations. Unit shall utilize voltage-matched Silicon Avalanche Suppressor Diode (SASD) technology. Unit shall utilize modular, plug-in suppressor design.

Manufacturer and Product: Transtector; Model Apex III (nonservice entrance distribution panelboard) or Apex IV (service equipment).

VOLT AND CURRENT METERS:

Voltmeter, Panel Type:

NEMA 250 Type 12.
Nominal 3-1/2 inch model.
90 degree scale; accuracy of plus or minus 2 percent.
Manufacturer: Same as Manufacturer of Motor Control Center.

Voltmeter Switch:

NEMA 250 Type 12.
Rotary cam type with pistol grip handle engraved escutcheon.
Four-position, phase-to-phase, and OFF.]

Manufacturer: Same as Manufacturer of Motor Control Center.

Ammeter, Panel Type:

NEMA 250 Type 12.
Nominal 3-1/2-inch model.
90 degree scale; accuracy of plus or minus 2 percent.

Manufacturer: Same as Manufacturer of Motor Control Center.

Ammeter Switch:

NEMA 250 Type 12.
Rotary cam type with pistol grip handle engraved escutcheon.
Four-position, three-phase currents, and OFF.

Manufacturer: Same as Manufacturer of Motor Control Center.

CONDUIT AND FITTINGS:

Rigid Galvanized Steel Conduit (RGS):

ANSI C80.1.

Fittings: Threaded type.

Galvanize by hot-dipping, electroplating, sherardizing, or metalizing process, including fittings.

Polyvinyl Chloride Conduit (PVC):

Rigid, Schedule 40, NEMA TC 2.
UL 651 listed for concrete encased, direct burial, concealed and direct sunlight exposed use.
UL 651 listed and marked for use with conductors having 90 degrees C insulation.

Fittings: NEMA TC 3, for intended use.

Flexible Metal Liquid-Tight Conduit:

UL 1 listed for liquid-tight service.
Galvanized steel, flexible conduit covered with extruded PVC jacket.

Termination: Nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring.

Interior Conduit Sealing:

Spare conduits should be capped in panels and handholes.

Conduits inside handholes will be sealed using spray insulating foam or other material, which is non-deleterious to conductors and cables.

Conduits inside panels will be sealed using insulating foam or other material, which is non-deleterious to conductors and cables.

Conduit Sealing Fitting:

Restrict the passage of gasses, vapors, or flames from one portion of the electrical installation to another at atmospheric pressure and normal ambient temperatures.

In conduit systems when leaving Class 1, Division 2 hazardous locations.

Manufacturers and Products:

Appleton; Type EYF, EYM, or ESU.

Crouse-Hinds; Type EYS or EZS.

Fitting Sealing Compound: Form a seal around each electrical conductor and between them and inside of the sealing fitting to restrict the passage of gases, vapors, or flames through the sealing fitting.

Manufacturers and Products:

Appleton; Kwiko.
Crouse-Hinds; Chico.

Identification Devices:

Conduit tags.

Material: Permanent, nylon.

Shape: Round.

Conduit Designation: Pressure stamped, embossed or engraved.

SUPPORT AND FRAMING CHANNELS:

Carbon Steel Framing Channel:

Material: Rolled, mild strip steel, 12-gauge, ASTM A570, Grade 33.

Finish: Hot-dip galvanized after fabrication.

Paint-Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

Manufacturers:

B-Line Systems, Inc.
Unistrut Corp.
Aickinstrut.

PRECAST UTILITY VAULTS, MANHOLES AND HANDHOLES:

Concrete Strength: Minimum 3,000 psi compressive, in 28 days.

Loading: AASHTO H-20, in accordance with ASTM C857.

Drainage: Slope floors toward drain points, leaving no pockets or other nondraining areas.

Raceway Entrances:

Provide on all four sides along with pulling eyes.

For raceways to be installed under this Contract, provide knockout panels or precast individual raceway openings.

At entrances where raceways are to be installed by others, provide minimum 12-inch high by 24-inch wide knockout panels for future raceway installation.

Handhole Frames and Covers:

Material: Steel, hot-dipped galvanized.

Cover Type: Solid, torsion spring of checkered diamond design.

Cover Loading: AASHTO H-20.

Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:

Above 600 Volts: ELECTRIC HV.

600 Volts and Below: ELECTRIC LV.

Instrumentation, Communication: Signal.

Hardware: Steel, hot-dip galvanized.

Furnish knockout for ground rod in each handhole.

Manufacturers:

Utility Vault Co.
Penn-Cast Products, Inc.
Concrete Conduit Co.
Associated Concrete Products, Inc.
Pipe, Inc.

CONDUCTORS 600 VOLTS AND BELOW:

Material: Annealed copper.

Insulation:

No. 8 AWG and Smaller: Type THW, THWN or XHHW conductors may be utilized at Construction General Contractor's option, subject to code requirements.

No. 6 AWG and Larger: Type XHHW.

Direct Buried: Type XLPE-USE.

Flexible Cord and Cable: Type SO, 600 volts.

Signal: Type 3, No. 16 AWG twisted, shielded pair instrumentation cable, 45-mil PVC outer jacket, 600-volt rating.

Type:

Control Conductor No. 14 AWG and Smaller: Stranded.

Power Conductors No. 10 AWG and Smaller: Solid or stranded.

Power Conductors No. 8 AWG and Larger: Stranded.

Type 3: No. 16 AWG stranded (copper seven-stranded)

CONDUCTORS ABOVE 600 VOLTS (SCHEDULE A WORK ONLY):

Ethylene-Propylene Rubber (EPR) Insulated Cable:

Extrusion: Single-pass, triple-tandem, of conductor screen, insulation, and insulation screen.

Type: 15kV, tape shielded UL 1072, Type MV-90.

Conductors: Copper concentric lay Class B round stranded in accordance with ASTM B3, ASTM B8, and ASTM B263.

Conductor Screen: Extruded, semi-conducting ethylene-propylene rubber in accordance with NEMA WC 71 and AEIC CS 6.

Insulation: 133 percent insulation level, ethylene-propylene rubber (EPR), containing no polyethylene in accordance with NEMA WC 71, and AEIC CS 6.

Insulation Thickness: 220-mil, 15 kV, nominal.

Insulation Screen: Thermosetting, semi-conducting ethylene-propylene rubber (EPR), extruded directly over insulation in accordance with NEMA WC 74, and AEIC CS 6.

Metallic Shield: Uncoated, 5-mil, copper shielding tape, helically applied with [17-1/2] percent minimum overlap.

Jacket: Extruded polyvinyl chloride (PVC) compound applied over the metallic shield in accordance with NEMA WC 71.

Operating Temperature: 90 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.

Manufacturers:

Okonite Co.
Pirelli Wire and Cable.
BICC.
Southwire Co.

ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS (SCHEDULE A WORK ONLY):

Termination Kits:

Capable of terminating 15 kV, single-conductor, polymeric-insulated tape shielded cables plus a shield ground clamp.

Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.

Capable of accommodating any form of cable shielding or construction without the need for special adapters or accessories.

Manufacturers:

Raychem.
3M Co.

Elbow Connector Systems:

Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95kV BIL, 200A, 10,000A rms load-break elbows as shown having all copper current-carrying parts in accordance with ANSI 386.

Protective Caps: Class 15 kV, 95 kV BIL, 200 amperes, with molded EPDM insulated body.

Insulated Standoff Bushings: Class 15kV, 95kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.

Bushing Inserts: 15kV, 95kV BIL, 200A, load-break with EPDM rubber body and all-copper, current-carrying parts.

Manufacturers:

Cooper Industries.
Elastimold.

Cable Lugs:

In accordance with NEMA CC1.
Rated 15kV of same material as conductor metal.

Manufacturers and Products, Uninsulated Compression Connectors and Terminators:

Burndy, Hydent.
Thomas & Betts; Color-Keyed.
ILSCO.

TERMINAL BLOCKS AND ENCLOSURES:

Provide enclosures for all indoor and outdoor terminal block applications in accordance with ENVIRONMENTAL CONDITIONS in this section..

Type: Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals.

Yokes and Clamping Screws: Zinc-plated, hardened steel.

Rating: 600V ac.

PUSHBUTTONS AND SELECTOR SWITCHES:

NEMA ICS 2, Type 600.

Type: Heavy-duty, oiltight.

Lockout: Pushbuttons and selector switches shall lock in OFF position wherever lockout provisions are indicated.

Nameplates:

Individual, large, laminated plastic.
Function indicated.
Pushbutton station nameplates shall indicate the drive controlled.

Manufacturers and Models:

Square D; Type T.
Cutler-Hammer; Type 10250T.
General Electric.

LUMINAIRES:

Specific requirements relating to fixture type, lamp type, poles, and mounting hardware are located in the Luminaire Schedule attached to this section**.**

RECEPTACLES:

NEMA WD 1 and FS W-C-596.

Specification Grade:

Type: Three-wire grounding, with screw type terminals suitable for No. 10 AWG wire. Contact to be made on two sides of each inserted blade without detent.

Number of Poles: Two.

Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.

Base: Phenolic composition.

Color: Gray.

SPECIAL OUTLETS:

Weatherproof outdoor heavy duty circuit breaking receptacle assembly and housing.
One matching plug with cord-grip features for each special purpose outlet.

Rating: 100-amp rating, 600 volts, three-phase, three-wire with ground (four-pole) as required for anticipated purpose.

Manufacturer and Model:

Crouse-Hinds, Arktite Style 2 AREA10425.
Or equal.

SWITCHES:

NEMA WD 1 and FS W-S-896E.
Totally enclosed, ac type, quiet tumbler switches, with screw terminals.
Capable of control of 100 percent tungsten filament and fluorescent lamp loads.

Rating: 20 amps, 120/277 volts (single and double-pole as required).

Color: Gray.

BOXES:

Small Standard Boxes:

NEMA 250, Type 1, minimum 2 inches deep, unless shallower required by structural conditions.

Large Galvanized Steel Boxes:

NEMA 250, Type 12 unless otherwise noted.
14-gauge, with full access screw covers mounted with corrosion-resistant machine screws.

Large Cast Metal Boxes:

NEMA 250, Type 4, (Type 7 for combined sumps), cast malleable iron, with hot-dip galvanized finish.

Neoprene gasketed, watertight, with cast metal covers, stainless steel screws, and drilled and tapped conduit entrances.

Handholes:

Reinforced cast concrete boxes sized to provide adequate working space as required by standard procedures and NFPA 70.

Nonmetallic:

Box: PVC.

Cover: PVC, weatherproof, with stainless steel screws.

Manufacturer and Product: Carlon; Type FS or FD, with Type E98 or E96 covers.

Large Nonmetallic Box:

NEMA 250, Type 4X.

Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.

Cover: Hinged with clamps.

Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.

Conduit hubs and mounting lugs.

Manufacturers and Products:

Crouse-Hinds; Type NJB.
Carlon; Series N, C, or H.
Robroy Industries.

METAL WIREWAYS:

Meet requirements of UL 870.

Type: Steel-enclosed, with removable, hinged cover.

Rating: Reference ENVIRONMENTAL CONDITIONS in this section.

Finish: Gray, baked enamel.

Manufacturers:

Circle AW.
Hoffman.
Square D.

COVER PLATES:

Metal:

Material: Specification grade, one-piece, stainless steel.

Thickness: Minimum 0.40-inch nominal.

Finish: No. 302/304 satin.

Mounting Screws: Oval head, stainless steel, to match plate.

Cast Metal:

Material: Malleable ferrous, with gaskets.

Mounting Screws: Oval head, stainless steel.

Weatherproof Device Plates:

Material: Cast metal, gasketed, weatherproof, with individual cap over each opening held with stainless steel springs.

Finish: Stainless steel or fiberglass reinforced plastic.

Mounting Screws: Stainless steel.

GROUNDING:

GENERAL:

Grounding shall be in compliance with NFPA 70 and ANSI C2.

Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, metal piping systems, and metal structures which may become energized by attached electrical devices (i.e., leachate storage tank, metal frame of buildings).

Shielded Instrumentation Cables:

Ground shield of instrumentation cables at PLC end only, using drain wire connected to terminal block that is connected to an isolated instrument ground. Isolated instrument ground terminals block is located inside PLC control panel enclosure.

Insulate ungrounded end of all shielded instrumentation cables' shield with shrink tubing for a distance of 1/2 inch either side of the end of the outer jacket.

Wire Connections:

Ground Conductors: Install in conduit containing power conductors and control circuits.

Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor and bond at both ends.

Connect ground conductors to raceway grounding bushings.

Bond all equipment grounding conductors to equipment ground bus and equipment enclosures as required by the NEC.

Bolt connections to equipment ground bus.

Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

Motor Grounding:

Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor and bond at both ends.

Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

Grounding Conductors:

Equipment: Solid or stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

Direct Buried: Bare stranded copper.

Isolated Instrument Ground: Stranded copper with green insulation with yellow stripe or yellow phasing tape at all ends.

Ground Rod:

Material: Copper.

Diameter: Minimum 3/4 inch.

Length: 10 feet.

Connectors:

Exothermic Weld Type:

Outdoor Weld: Suitable for exposure to elements or direct burial.

Indoor Weld: Utilize low-smoke, low-emission process.

Manufacturers: Erico Products, Inc., Cadweld and Cadweld Exolon.

Compression Type:

Compress-deforming type; wrought copper extrusion material.
Single indentation for conductors 6 AWG and smaller.
Double indentation with extended barrel for conductors 4 AWG and larger.
Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.

Manufacturers:

Burndy Corp.
Thomas and Betts Co.
ILSCO Corp.
Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

Manufacturers:

Burndy Corp.

Thomas and Betts Co.

ILSCO Corp.

Grounding Wells:

Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

Manufacturers and Products:

Christy Co.; No. G5.

Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 – EXECUTION

GENERAL:

All work shall be performed in a neat and workman-like manner and shall comply with all applicable provisions of NECA 5055 standards and practices.

Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the hazardous area indicated.

Ground equipment, enclosures, and complete conduit system securely in accordance with applicable sections of NFPA 70.

PANELBOARDS AND MINI-POWER CENTERS

Install securely, plumb, in-line and square with walls.
Install top of cabinet 6 feet above floor, unless otherwise shown.
Provide typewritten circuit directory for each panelboard.

Cabinet Location/Type:

Industrial Use in Areas Not Otherwise Classified: Reference ENVIRONMENTAL CONDITIONS in this section.

TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) EQUIPMENT

Install in accordance with manufacturer's instructions, including lead length, overcurrent protection, and grounding.

MOTOR STARTER:

Field adjust trip settings of motor starter magnetic, trip-only circuit breakers in accordance with manufacturer's instructions.

CONDUIT AND FITTINGS:

General:

Conduit system shall be carefully planned with proper attention to details before starting the work.

Do not install crushed or deformed raceways. Replace any raceway that has been damaged after installation.

Raceways that are installed so as to form a moisture trap are not allowed.

Prevent plaster, dirt, or trash from lodging in raceways, boxes, fittings, and equipment during the course of construction. Clear clogged raceways of obstructions.

All conduit runs shall be made parallel to or perpendicular to the lines of the building.

Secure conduits entering cabinets, pull boxes or outlet boxes with galvanized locknuts and bushings, on both sides of box wall.

Identify conduits at each terminus using conduit and cable schedule designations.

Applications:

Exposed Exterior: Type RGS.

Concrete Embedded: Type PVC.

Direct Buried: Type PVC inside concrete duct bank.

Vertical Runs Through Slab on Grade: Convert PVC conduit to RGS wrapped with watertight adhesive plastic tape.

PVC Bends: Bends in PVC runs shall be incorporated using RGS. RGS wrapped with watertight adhesive plastic tape.

Final Connection to Motors:

Conduit Size 4 Inches or Less: 18-inch minimum, 60-inch maximum length of flexible liquid-tight metal conduit.

Penetrations:

Conduits penetrating fire-rated walls shall be sealed with a compound approved by UL and appropriate to the fire rating of the wall.

Flash and counterflash conduits penetrating roofing membrane.

Seal penetrations with oakum or expandable plastic compound.

Provide sleeves and chases where conduits pass through floors or walls. Finish to match adjacent surfaces.

Provide escutcheon plates where exposed conduits pass through walls, floors or ceilings.

Conduits from the combined sump area shall be sealed with a compound approved by UL, and appropriate for conduits in hazardous areas entering nonhazardous areas.

Slab-On-Grade or Direct Buried:

Install horizontal runs below floor slab. Horizontal runs within slab shall not be permitted.

Field wrap RGS conduit and joints installed below slab or direct buried with 0.010-inch thick pipe wrapping plastic tape applied with a 50 percent overlay, or factory apply a plastic resin, epoxy, or coal-tar coating system.

Exposed Raceways:

Install parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

Underground Duct Banks:

All underground duct banks shall be installed in locations shown on drawings, enclosed in a red concrete casing as specified in Section 03301, CONCRETE. The concrete casing shall also enclose all standard conduit bends or elbows. All underground ducts shall have steel reinforcement in sizes as shown on the drawings.

Excavate the trenches as specified in Section 02316, EXCAVATION, to provide elevation on top of concrete envelope as shown on drawings. After trenches are excavated and graded, the duct shall be laid in rows on plastic spacers or approved equals.

Spacers shall be placed so that each section of duct is supported at intervals as specified in NFPA 70 (NEC). Concrete shall then be placed per Section 03301, CONCRETE, until the ducts are covered to the required depth and leveled, leaving NOT less than 4 inches of concrete over top tier of ducts. Backfill shall be in accordance with Section 02320, TRENCH BACKFILL.

Changes in Direction of Runs:

Make with symmetrical bends or cast metal fittings.

Bends and offsets shall be made with a hickey or conduit bending machine.

Supports:

Provide pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps with retainers, or ceiling trapeze.

Install suitable braces for conduit, junction boxes, light fixtures and other electrical equipment as needed for seismic support.

Securely and rigidly fasten in place.

Maximum Interval: 10 feet.

PRECAST UTILITY VAULTS, MANHOLES AND HANDHOLES:

Excavate, shore, brace, backfill, and final grade in accordance with Section 02316, EXCAVATION and Section 02320, TRENCH BACKFILL.

Do not install until final raceway grading has been determined.

Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

CONDUCTORS:

Conduit system shall be complete prior to drawing conductors.

Lubricate prior to drawing into conduit. Lubrication type shall be as approved by conductor manufacturer.

Connections: Pressure type solderless, complete with insulator and security ring.

Control Circuits:

Where multiple units perform parallel operations, do not group all devices on same branch circuit.

Do not exceed the ampacity of the branch circuit, or 12 amperes continuous.

Terminate feeder and interconnecting conductors between panel mounted equipment and external equipment at numbered terminal blocks.

Identification:

Where two or more conduits run to a single outlet box, color code each circuit as a guide in making connections.

Carry colors continuously throughout the system.

Do not install multiwire branch circuits that share a common neutral.

Identify conductors, cables at each terminus, and handhole using conduit and cable schedule designations.

Colors:

Confirm and utilize the existing Hanford field center color coding system as shown below:

Conductor Origin: 480Y/277-volt, three-phase system. Transformers, panels, switchboard, etc.

Phase A	Red
Phase B	Yellow
Phase C	Blue
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: 208Y/120-volt, three-phase system. Transformers, panels, switchboard, etc.

Phase A	Black
Phase B	Purple
Phase C	Brown
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: 120/240-volt, single-phase system. Transformers, panels, switchboard, etc.

Hot Number 1	Black
Hot Number 2	Brown
Neutral	White or Gray
Equipment Ground	Green (or bare)

Conductor Origin: DC system. Instruments, control panels, etc.

DC +	Red
DC-	Black

CONDUCTORS ABOVE 600 VOLTS (SCHEDULE A WORK ONLY):

Do not splice conductors.

Single Conductor Cable Terminations:

Coordinate all terminations with FH EU.

Make terminations with termination kits, in accordance with kit manufacturer's instructions. Install terminations as continuous operation in accessible locations under clean, dry conditions.

Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing plus a ground braid and clamp.

Install terminals or connectors acceptable for type of conductor material used.

Provide shield termination and grounding for all terminations.

Provide necessary mounting hardware, covers, and connectors.

Where elbow connectors are specified, install in accordance with manufacturer's instructions.

Connections and Terminations:

Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.

Give 2 working days notice to FH EU prior to making terminations.

TERMINAL BLOCKS:

Install for termination of all control circuits leaving or entering equipment, panels, or boxes.

LUMINAIRES:

Install luminaires and poles in accordance with manufacturer's recommendations.
Install plumb and true.
Provide swivel type hangers and canopies to match pendant mounted fixtures.
Furnish all lamps and clean the reflectors, the diffusers, and the lamps before closing up the fixtures.

BOXES:

Support to the structure, independent of conduit attachment.

Boxes installed belowgrade shall be installed flush with finished grade.

Boxes and covers in paved areas, roadways, or walkways shall be suitable for weights to which they may be subjected.

Box Extensions: Not permitted.

Classified Hazardous Areas: Boxes shall be applicable for location.

COVER PLATES:

Shall fit tightly to box.

Shall not extend beyond sides of box on surface mounted boxes, unless covers have no sharp corners or edges.

TRENCH BACKFILL:

In accordance with Section 02320, TRENCH BACKFILL.

PROTECTION FOLLOWING INSTALLATION:

Protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation.

Cap conduit runs during construction with manufactured seals.

Close openings in boxes or equipment during construction.

Energize space heaters furnished with equipment.

CONSTRUCTION QUALITY CONTROL:

In accordance with Section 16080, ELECTRICAL TESTING, and as specified herein.

Circuit Balance:

Confirm the balance of electrical load between phases on three-phase panelboards and motor control centers after installation. Notify Construction Manager of current unbalances 10 percent and greater.

Voltage Testing:

When installation is complete and facility is in operation, check voltage at point of termination of electric supply system to project.

Check voltage amplitude and balance between phases for loaded and unloaded conditions.

Record supply voltage for 24 continuous hours. If unbalance exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded conditions more than plus or minus 4 percent of nominal, make written request to Tank Farm Contractor to correct condition.

Equipment Line Current:

Check line current in each phase for each piece of equipment.

If electric utility makes adjustments to supply voltage magnitude or balance, make line current check after adjustments are made.

Inspection of Low Voltage Cables, 600 Volts Maximum (Note: FH EU shall inspect and test all cables rated above 600 volts):

Inspect each individual exposed power cable for physical damage, proper connections in accordance with Section 16080, ELECTRICAL TESTING.

Electrical Tests for Conductors (600 Volts and Below):

Prior to final connection and energizing of power and control circuits, conduct an insulation resistance test to determine insulation integrit in accordance with Section 16080, ELECTRICAL TESTING.

Ground Electrode Test:

Inspect grounding connections prior to any backfill of cables in accordance with Section 16080, ELECTRICAL TESTING.

Maximum ground electrode resistance shall be 3 ohms. Add maximum 2 additional ground rods spaced 6 feet apart if 3 ohms is not achieved.

SUPPLEMENTS:

The supplement listed below, following "END OF SECTION," is a part of this Specification.

Supplement 1—Luminaire Schedule.

END OF SECTION 16005

Luminaire Schedule

Type	Voltage	Description	Manufacturer	Catalogue No.	Lamp	Mounting Type
1	120	Heavy duty industrial 4-foot fluorescent fixture with 2 lamps with low temp electronic starting ballast(s).	Holophane	7200-4-12-LT Fluorescent Prismatite or equal.	2-40W R.S. T12, 0°F starting (48″)	Pendant with chains and surface mount
2	120	Standby light NiCaD battery operated.	Holophane	C1-6N-25-W-WCHY-2 Cortez A1	2-12 watts 6-volt Halogen	Wall mount
3	120	WallPack wall mount HPS with integral photocell.	Holophane	WallPack WL2K-070HP-12-BK—F1-LAMP-PC	1-70W HPS	Wall mount
4	120	Pole mount outdoor flood wet location duty. Single and double 2U configuration as indicated.*	Holophane	Predator Floodlight PF-250HP-12-K-W-1-B-CR[2]	250-watt HPS	Pole mount round tapered steel poles, single and 2U configurations SPRT20J/1/SG SPRT20J/2/SG
5	120	Crestwood outdoor post light with HPS fixture and cover*	Holophane	Crestwood CW-24-15AHP-12-GR-CA	1-150W HPS	Round tapered steel galvanized pole 10 foot SPRT10J/SG
Note: *Install added vertical light cutoff "shades."						

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SECTION 16055 – PIPE HEAT TRACING Sched. B

PART 1 – GENERAL

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Manufacturer's descriptive literature.

Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.

Pipe heat loss calculations for each pipe size to be heat traced.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Field Testing: Submit inspection/test report on insulation resistance per CONSTRUCTION QUALITY CONTROL section of this Specification.

PART 2 – PRODUCTS

SYSTEM DESIGN REQUIREMENTS:

Design Heating Load:

Heating load to be calculated based upon a 100-degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 15060, PIPING-GENERAL, and shall include a 10 percent safety factor.

Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

ELECTRICAL HEATING TAPE:

Cable: Auto-trace, self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

Minimum Maintenance Temperature: Minus 40 degrees F (-40 degrees C).

Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings. All heat trace circuits shall be powered by ground fault interrupter type (GFEP) circuit breakers (30 mA).

Manufacturers and Products:

Raychem; Chemelex BTV or BRV-C.
Thermon; FLX-BC or FLX-OJ.
Nelson; CL1-J1 or L1-J1.

CONNECTION SYSTEM:

Rating: NEMA 250, Type 4 and Factory Mutual approved.

Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

Manufacturers and Products:

Power Connection Kit:

Raychem; Chemelex AM-BC.
Thermon; PCA-COM.
Nelson; PLT-BC.

Splice Kit:

Raychem; Chemelex AM-BS.
Thermon; PCS-COM.
Nelson; PLT-BS.

Tee Kit:

Raychem; Chemelex AM-B4.
Thermon; Tee Snap.
Nelson; PLT-BY.

End Seal Kit:

Raychem; Chemelex AM-E.
Thermon; ET-6C or ET-8C.
Nelson; LT-ME.

Pilot Light:

Raychem; Chemelex AM-L.
Thermon; VIL-4C.
Nelson; LT-L.

Pipe Adapter Kit:

Raychem; Chemelex AM-P or AM-T.
Thermon; included with power connection kit.
Nelson; LT-P.

SECURING TAPE:

Plastic Piping Systems:

Type: Aluminum foil coated adhesive tape.

Manufacturers and Products:

Raychem; Chemelex AT-180.
Thermon; AL-20P.
Nelson; AT-50.

Metallic Piping Systems:

Type: Glass or polyester cloth pressure sensitive tape.

Manufacturers and Products:

Raychem; Chemelex GS54 or GT66.
Thermon; PF-1.
Nelson; GT-6 or GT-60.

AMBIENT THERMOSTAT:

Type: Adjustable setting (15 to 140 degrees F), set to 40 degrees F, so as to switch cable off when ambient temperature exceeds 40 degrees F.

Sensor: Fluid-filled probe.

Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

Manufacturers and Products:

Raychem; Chemelex Model AMC-1A.
Thermon; B4X-15140.
Nelson; TX-4X140.

PART 3 – EXECUTION

INSTALLATION:

General:

Install in accordance with the manufacturer's instructions and recommended practices.

Provide insulation as specified in Section 15060, PIPING-GENERAL, over all pipe heat tracing.

Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.

Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.

Provide end of circuit pilot lights on heat tracing circuits for buried piping.

Electrical Heating Tape:

Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.

Where design heating load exceeds heating tape capacity, install by spiraling.

Derate heating tape capacity when installed on plastic piping.

Install on services as follows (reference Drawings H-2-830854, Sheets 2 and 4):

Service	Piping Material	Placement	Location
Cell No. 1	3″ LH-030-HDPE	Heat trace and insulate exposed portion of piping from tank inlet connection to about 2 feet below grade.	Cell No. 1 and Cell No. 2
Cell No. 2	3″ LH-030-HDPE		Leachate Storage Tank(s) Process Inlet Connections.
Cell No. 1	4″ LT-034-PVC	Heat trace and insulate exposed portion of piping from tank inlet connection to about 2 feet below grade.	Cell No. 1 and Cell No. 2
Cell No. 2	4″ LT-034-PVC	Connections	Outlet
Cell No. 1	4″ LH-045-HDPE	Heat trace and insulate exposed portion of piping from tank inlet	Cell No. 1 and Cell No. 2
Cell No. 2	4″ LH-045-HDPE	Connection to about 2 feet below grade.	Leachate Storage Tank(s) Process Inlet Connections.
Cell No. 1	4″LT-037-HDPE	Heat trace and insulate exposed portion of piping from above grade	Cell No. 1 and Cell No. 2 Truck
Cell No. 2	4″LT-037-HDPE	Connection fittings to about 2 feet below grade, including 8″ containment piping.	Loading Station(s) Process to Truck Connections.

Wrap heat trace cable once every 33 inches under pipe insulation. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

Thermostats:

Install in accordance with manufacturer's instructions and as approved by Engineer.

For each group of heat traced circuit, install one ambient thermostat.

CONSTRUCTION QUALITY CONTROL:

In accordance with Section 16080, ELECTRICAL TESTING, and as specified herein.

Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION 16055

SECTION 16080 – ELECTRICAL TESTING Sched. A &B

PART 1 – GENERAL

Fluor Hanford Electrical Utilities (FH EU) shall test pad mounted transformer and conductors rated above 600 volts. Construction General Contractor shall coordinate FH EU testing with Construction Manager.

Onsite testing shall be required for each major electrical system as specified herein in the presence of representatives for the authority having jurisdiction (AHJ). Tests shall be performed to demonstrate that each function is implemented and operational. These tests are electrical component tests to be performed in advance of facility-wide construction acceptance testing (CAT). CAT shall be performed in accordance with Division requirements.

Provide personnel and equipment in support of Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), Operation Readiness (ORT) and Performance Acceptance (PAT) testing.

APPROVAL BY AUTHORITY HAVING JURISDICTION (AHJ):

As specified in Section 16005, ELECTRICAL.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Qualifications: Submit Testing Firm Qualifications as specified herein.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR)

Submit 30 days prior to performing inspections or tests:
Schedule for performing inspection and tests.
List of references to be used for each test.
Sample copy of equipment and materials inspection form(s).
Sample copy of individual device test form.
Sample copy of individual system test form.
Submit within 30 days after completion of test:
Test or inspection reports and certificates for each electrical item tested.

Operation and Maintenance Data:

After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in operation and maintenance manual.

TESTING FIRM QUALIFICATIONS:

Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years' testing experience on similar projects.

Technicians certified by NICET or NETA.

Registered professional engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.

In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories.

SEQUENCING AND SCHEDULING:

Perform inspection and electrical tests after equipment has been installed. Construction General Contractor shall coordinate NEC required inspections and Fluor Hanford Electrical Utilities (FH EU) required testing and inspections with Construction Manager. Tank Farm Contractor will provide services of an NEC inspector.

Perform tests with apparatus de-energized whenever feasible.

Inspection and electrical tests on energized equipment are to be:

Scheduled with Construction Manager prior to de-energization.

Minimized to avoid extended period of interruption to the operating plant equipment.

Notify Construction Manager at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 – PRODUCTS

TEST EQUIPMENT/INSTRUMENTATION REQUIREMENTS:

Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

Test instrument calibration shall be in accordance with NETA ATS.

PART 3 – EXECUTION

GENERAL:

Tests and inspection shall establish that:

Electrical equipment is operational within industry and manufacturer's tolerances.

Installation operates properly.

Equipment is suitable for energization.

Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

Adjust mechanisms and moving parts for free mechanical movement.

Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

Verify nameplate data for conformance to Contract Documents.

Realign equipment not properly aligned and correct unlevelness.

Properly anchor electrical equipment found to be inadequately anchored.

Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

Provide proper lubrication of applicable moving parts.

Inform Construction Manager of working clearances not in accordance with NFPA 70.

Investigate and repair or replace:

Electrical items that fail tests.

Active components not operating in accordance with manufacturer's instructions.

Damaged electrical equipment.

Electrical Enclosures:

Remove foreign material and moisture from enclosure interior.

Vacuum and wipe clean enclosure interior.

Remove corrosion found on metal surfaces.

Repair or replace, as determined by Construction Manager, door and panel sections having dented surfaces.

Repair or replace, as determined by Construction Manager, poor fitting doors and panel sections.

Repair or replace improperly operating latching, locking, or interlocking devices.

Replace missing or damaged hardware.

Finish:

Provide matching paint and touch up scratches and mars.

If required due to extensive damage, as determined by Construction Manager, refinish the entire assembly.

Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

DRY TYPE TRANSFORMERS:

Visual and Mechanical Inspection:

Physical and insulator damage.
Proper winding connections.
Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
Defective wiring.
Proper operation of fans, indicators, and auxiliary devices.
Removal of shipping brackets, fixtures, or bracing.
Free and properly installed resilient mounts.
Cleanliness and improper blockage of ventilation passages.
Verify that tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 7.2.3 for each:

Winding-to-winding.

Winding-to-ground.

10-minute test duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

Results temperature corrected in accordance with NETA ATS, Table 7.2.4.

Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

Insulation resistance test results to compare within 1 percent of adjacent windings.

Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM:

Visual and Mechanical Inspection:

Inspect Each Individual Exposed Power Cable No. 8 and Larger For:

Physical damage.

Proper connections in accordance with single-line diagram.

Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

Color coding conformance with specifications.

Proper circuit identification.

Mechanical Connections For:

Proper lug type for conductor material.
Proper lug installation.
Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.

Shielded Instrumentation Cables For:

Proper shield grounding.
Proper terminations.
Proper circuit identification.
Continuity test by ohmmeter method to ensure proper cable connections.

Control Cables For:

Proper termination.
Proper circuit identification.
Continuity test by ohmmeter method to ensure proper cable connections.

Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

Electrical Tests for Conductors No. 8 and Larger:

Insulation Resistance Tests:

Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.

Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.

Evaluate ohmic values by comparison with conductors of same length and type.

Investigate values less than 50 megohms.

Continuity test by ohmmeter method to ensure proper cable connections.

SAFETY SWITCHES, 600 VOLTS MAXIMUM:

Visual and Mechanical Inspection:

Proper blade pressure and alignment.
Proper operation of switch operating handle.
Adequate mechanical support for each fuse.
Proper contact-to-contact tightness between fuse clip and fuse.
Cable connection bolt torque level in accordance with NETA ATS, Table 10.1.
Proper phase barrier material and installation.
Verify that fuse sizes and types correspond to one-line diagram.
Perform mechanical operational test and verify electrical and mechanical interlocking system operation and sequencing.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.
Phase-to-phase and phase-to-ground for 1 minute on each pole.
Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

Contact Resistance Tests:

Contact resistance in microhms across each switch blade and fuse holder.
Investigate deviation of 50 percent or more from adjacent poles or similar switches.

MOLDED AND INSULATED CASE CIRCUIT BREAKERS:

General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 30 amperes and larger.

Visual and Mechanical Inspection:

Proper mounting.
Proper conductor size.
Feeder designation according to nameplate and one-line diagram.
Cracked casings.
Connection bolt torque level in accordance with NETA ATS, Table 10.1.
Operate breaker to verify smooth operation.
Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
Verify that terminals are suitable for 75 degrees C rated insulated conductors.
Electrical Tests:

Insulation Resistance Tests:

Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.

Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute

Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

Test values to comply with NETA ATS, Table 10.2.

Contact Resistance Tests:

Contact resistance in microhms across each pole.
Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

Current Injection Test to Verify:

Long-time minimum pickup and delay.

Short-time pickup and delay.

Instantaneous pickup by run-up or pulse method.

Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

Trip times shall be within limits established by NEMA AB 4, Table 5-3.

Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

INSTRUMENT TRANSFORMERS:

Visual and Mechanical Inspection:

Visually Check Current, Potential, and Control Transformers For:

Cracked insulation.
Broken leads or defective wiring.
Proper connections.
Adequate clearances between primary and secondary circuit wiring.

Verify Mechanically That:

Grounding and shorting connections have good contact.
Withdrawal mechanism and grounding operation, when applicable, operate properly.
Verify proper primary and secondary fuse sizes for potential transformers.

Electrical Tests:

Current Transformer Tests:

Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.

Polarity test.

Potential Transformer Tests:

Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:

Winding-to-winding.

Winding-to-ground.

Polarity test to verify polarity marks or H1-X1 relationship as applicable.

Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

UTILITY METERING:

Testing to be conducted by FH EU.

GROUNDING SYSTEMS:

Visual and Mechanical Inspection:

Equipment and circuit grounds in motor control center and panelboard assemblies for proper connection and tightness.

Ground bus connections in motor control center and panelboard assemblies for proper termination and tightness.

Effective transformer core and equipment grounding.

Accessible connections to grounding electrodes for proper fit and tightness.

Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

Electrical Tests:

Fall-Of-Potential Test:

In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance. Main ground electrode system resistance to ground to be no greater than 3 ohms.

Two-Point Direct Method Test:

In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.

Equipment ground resistance shall not exceed main ground system resistance by 0.25 ohm.

AC INDUCTION MOTORS:

General: Inspection and testing limited to motors rated 1/3 hp and larger.

Visual and Mechanical Inspection:

Proper electrical and grounding connections.
Shaft alignment.
Blockage of ventilating air passageways.

Operate Motor and Check For:

Excessive mechanical and electrical noise.

Overheating.

Correct rotation.

Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.

Excessive vibration.

Check operation of space heaters.

Electrical Tests:

Insulation Resistance Tests:

In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

LOW VOLTAGE MOTOR CONTROL:

Visual and Mechanical Inspection:

Proper barrier and shutter installation and operation.
Proper operation of indicating and monitoring devices.
Proper overload protection for each motor.
Improper blockage of air cooling passages.
Proper operation of drawout elements.
Integrity and contamination of bus insulation system.

Check Breaker and Kirk Key Interlocking System By:

Closure attempt of breaker when associated Kirk key is in place.
Open attempt of breaker when associated Kirk key is in place.
Closure attempt of breaker when associated Kirk key is not in place.
Open attempt of breaker when associated Kirk key is not in place.

Check Door and Device Interlocking System By:

Closure attempt of device when door is in OFF or OPEN position.
Opening attempt of door when device is in ON or CLOSED position.

Check Nameplates for Proper Identification Of:

Equipment title and tag number with latest one-line diagram.
Control switches.
Pilot lights.
Control relays.
Circuit breakers.
Verify that fuse and circuit breaker sizes and types conform to Contract Documents.
Verify that current and potential transformer ratios conform to Contract Documents.

Check Bus Connections for High Resistance by Low Resistance Ohmmeter: Ohmic value to be zero.

Check Operation and Sequencing of Electrical and Mechanical Interlock Systems By:

Closure attempt for locked open devices.
Opening attempt for locked closed devices.
Key exchange to operate devices in OFF-NORMAL positions.
Verify performance of each control device and feature furnished as part of the motor control center.

Control Wiring:

Compare wiring to local and remote control, and protective devices with elementary diagrams.
Check for proper conductor lacing and bundling.
Check for proper conductor identification.
Check for proper conductor lugs and connections.
Exercise active components.

Inspect Contactors For:

Correct mechanical operations.
Correct contact gap, wipe, alignment, and pressure.
Correct torque of all connections.
Compare overload settings and voltage ratings with full-load current for proper size.
Compare fuse motor protector and circuit breaker with motor characteristics for proper size.

Electrical Tests:

Insulation Resistance Tests:

Applied megohmmeter dc voltage in accordance with NETA ATS, Table 10.2.

Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

Contactor phase-to-ground and across open contacts for 1 minute on each phase.

Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.

Test values to comply with NETA ATS, Table 10.2.

Overpotential Tests:

Maximum applied ac or dc voltage in accordance with NETA ATS, Table 7.1.2.
Phase-to-phase and phase-to-ground for 1 minute for each phase of each bus section.
Test results evaluated on pass/fail basis.

Current Injection Through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:

Trip time in accordance with manufacturer's published data.

Investigate values in excess of 120 seconds.

Control Wiring Tests:

Apply secondary voltage to control power and potential circuits.

Check voltage levels at each point on terminal boards and each device terminal.

Insulation resistance test at 1,000 volts dc on control wiring except that connected to solid state components.

Insulation resistance to be 1 megohm minimum.

Operational test by initiating control devices to affect proper operation.

LOW VOLTAGE SURGE ARRESTORS:

Visual and Mechanical Inspection:

Adequate clearances between arrestors and enclosures.
Ground connections to ground bus and electrode.

Electrical Tests:

Varistor Type Arrestors:

Clamping voltage test.
Rated RMS voltage test.
Rated dc voltage test.
Varistor arrestor test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

END OF SECTION 16080

SECTION 16270 – OIL-FILLED PAD MOUNTED TRANSFORMERS

Sched. A

PART 1 – GENERAL

REFERENCES:

The following is a list of standards, which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ANSI C57.12.22	Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller
ANSI C57.12.26	Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment, Enclosure Integrity
ANSI C57.12.90	Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE C62.11	Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 KV)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Descriptive information.
Dimensional drawings.
Transformer nameplate data.
Schematic and connection diagrams.
Factory test reports certified.

SUBMITTALS–APROVAL NOT REQUIRED:

Information/Record (IR):

Operation and maintenance data.
Material Safety Data Sheet (MSDS) for Envirotemp FR3™ Fluid.
Submit documentation and test results from construction quality control testing.

EXTRA MATERIALS:

Furnish, tag, and box for shipment and storage and deliver prior to 30 percent Project completion the following spare parts, special tools, and materials:

One quart of paint to match color and quality of equipment final shop finish.

Two spare fuse links for each fuse size.

PART 2 – PRODUCTS

SOURCE QUALITY CONTROL (FACTORY TESTS):

Design, test, and assemble in accordance with applicable standards of ANSI C57.12.00, C57.12.22, C57.12.26, and C57.12.90.

Production tests in accordance with ANSI C57.12.90 and C57.12.00, Section 8 and Table 16.

Dielectric test in accordance with ANSI C57.12.26.

MANUFACTURERS:

Cooper Power System.
Cutler-Hammer.
Square D Co.
General Electric.

GENERAL:

Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.

Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

TRANSFORMER:

kVA Rating: 112.5.

Primary Voltage: 13.8 kV line-to-line, three-phase, 60 Hz.

Secondary Voltage: 480/277 volts, three-phase, four-wire, 60 Hz.

BIL Rating:

95 BIL for 15 kV insulation class transformers.
30 BIL for secondary.

Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

Impedance: 3.2 percent.

Coolant: Normally formulated, hydro-refined oil free of PCB chemical, FMRC approved, UL classified less-flammable Envirotemp FR3, in accordance with FMRC 3990. Fluid shall have a minimum open cup fire point of 350 degrees C and a minimum 5-day BOD (SM5210B) of 200 ppm. Manufacturer is to provide information on the transformers nameplate that it is "NON-PCB" along with "manufacturer's name and type of insulating fluid."

Primary Taps:

Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
Externally operated no-load tap changer.
Provisions for locking handle in any position.

Coil Conductors: Copper windings.

Delta-wye transformers wound on triplex cores.

Sound Level: In accordance with manufacturer’s standards.

ENCLOSURE:

In accordance with ANSI C57.12.28 requirements.

Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.

12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

Corrosion Protection and Color: Base(s) and cabinet(s) of the transformer shall be corrosion resistant and shall be fabricated of steel. Provide insulating and corrosion resistance undercoating on base of transformer. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. The Munsell color notation is specified in ASTM D1535.

TERMINAL COMPARTMENTS:

General: ANSI C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.

Doors:

Individual, full-height, air-filled.
Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
High voltage door fastenings inaccessible until low voltage door has been opened.

Door Bolts: Hex-head type.

Lift-off, stainless steel hinges and door stops.
Removable front sill to facilitate rolling or skidding over conduit stub ups.
Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.

High Voltage Compartment:

Deadfront in accordance with ANSI C57.12.26 type construction.
Protective fuses.
High voltage bushings.
Transformer grounding pad.
Surge arrestors with barriers.
Four-position, oil-immersed type switch to permit closed transit in loop feed and sectionalizing position sectionalizing load-break switch.
Parking stands.

Low Voltage Compartment:

Livefront in accordance with ANSI C57.12.26 type construction.
Low voltage bushings.
Grounding pad.
Stainless steel equipment nameplate.
Liquid level gauge.
1-inch upper filter press and filling plug.
Drain valve with sampling device.
Dial type thermometer.
Pressure relief valve.
Pressure relief device, self-resealing with indicator.
Pressure-vacuum gauge.
Mounting provision for current and potential transformers.
Nameplate per Nameplate C, Table 9, IEEE C57.12.00.

BUSHINGS:

High Voltage:

Deadfront Termination:

Universal bushing well rated at 15 kV in accordance with ANSI 386.
Bushings externally clamped and front removable.
Rated for 200 amperes continuous, 95 kV BIL.
Standoff brackets located adjacent to bushings.

Low Voltage:

Molded epoxy bushing clamped to tank with 4 hole spade type terminals.
Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.
Internally connected neutral extending to neutral bushing.

HIGH VOLTAGE SWITCHING:

Internal, oil-immersed, gang-operated load-break, manually operated switches.
Hot stick operated handle located in high voltage compartment.
Capable of operating at full-load current.

Feed Switch: Four-position, oil-immersed type switch to permit closed transition loop feed and sectionalizing. Switch shall be rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 10,000 rms amperes symmetrical. The switch handle shall be located in the high-voltage compartment and lockable in the ON/OFF position. Switch shall be similar to the Cooper Power Systems, Electrical Apparatus 800-64, Sectionalizing Switches, “T” blade switch.

HIGH VOLTAGE PROTECTION:

Combination Oil-Immersed Bayonet Expulsion and Current Limiting Fuses:

Accessibility:

Bayonet expulsion fuse accessible through primary compartment.
Current-limiting fuse accessible through tank handhole.

Expulsion Fuse for Low Current Faults: Interrupting capacity of 1,800 amperes rms asymmetrical.

Current Limiting for High Current Faults: Interrupting capacity of 50,000 amperes rms symmetrical.

Bayonet fuse externally replaceable with hot stick.

Bayonet fuse links shall be dual sensing for both high currents and high oil temperature in order to provide thermal protection to the transformer.

Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse.

In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing, which closes when the fuse holder is removed and an external drip shield.

Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the OPEN position and the tank pressure has been released.

Bayonet Fuse Assembly: 150 kV BIL.

Oil-Immersed Current-Limiting Fuses: NEMA C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

SURGE ARRESTORS:

Metal-Oxide, Varistor Type:

Insulated body, elbow type, 18 kV in accordance with IEEE C62.11.

Installed in high voltage compartment.

Connected to transformer high voltage bushing wells.

TANK GROUNDING PADS:

Low Voltage Compartments:

Connected together with bare No. 2/0 stranded copper conductors.

Wye low voltage neutral internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.

Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

TAP CHANGER WARNING SIGN:

Red laminated plastic, engraved to white core.

Engrave to read DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

Mount above tap changer handle.

PART 3 – EXECUTION

GENERAL:

Prepare subgrade for utility vault for pad mounted transformer as specified in Section 02319, SUBGRADE PREPARATION, paragraph “Prepared Subgrade for Roadway, Embankment and Structures.”

Secure to mounting pads with anchor bolts.

Install plumb and longitudinally in alignment with pad or adjacent building wall.

Ground neutrals and enclosures in accordance with applicable codes and as shown on the Drawings.

CONSTRUCTION QUALITY CONTROL:

In accordance with Section 16080, ELECTRICAL TESTING.

ADJUSTMENTS:

Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION 16270

SECTION 16270-1 – SINGLE PHASE OIL-FILLED PAD MOUNTED TRANSFORMERS Sched. B

PART 1 – GENERAL

REFERENCES:

The following is a list of standards which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
ANSI C57.12.21	Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings, 167 kVA and Smaller
ANSI C57.12.25	Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment, Enclosure Integrity
ANSI C57.12.90	Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers
ANSI 386	Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Descriptive information.
Dimensional drawings.
Transformer nameplate data.
Schematic and connection diagrams.
Factory test reports certified.

SUBMITTALS–APROVAL NOT REQUIRED:

Information/Record (IR):

Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Material Safety Data Sheet (MSDS) for Envirotemp FR3™ Fluid.
Submit documentation and test results from construction quality control testing.

EXTRA MATERIALS:

Furnish, tag, and box for shipment and storage and deliver prior to 30 percent Project completion.

PART 2 – PRODUCTS

SOURCE QUALITY CONTROL (FACTORY TESTS):

Design, test, and assemble in accordance with applicable standards of ANSI C57.12.00, C57.12.21, C57.12.25, and C57.12.90.

Production tests in accordance with ANSI C57.12.90, Section 8 and Table 16.

Dielectric test in accordance with ANSI C57.12.25.

MANUFACTURERS:

Cooper Power System; Maxishrub type.
ABB.

GENERAL:

Integral Unit: Compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartment, assembled on a common base.

Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

TRANSFORMER:

kVA Rating: 75.

Primary Voltage: 13.8 kV line-to-line, single-phase, 60 Hz.

Secondary Voltage: 120/240 volts, single-phase, three-wire, 60 Hz.

BIL Rating:

95 BIL for 15 kV insulation class transformers.

30 BIL for secondary.

Temperature Rise: 65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.

Impedance: 3.2 percent, minimum.

Coolant: Normally formulated, hydro-refined oil free of PCB chemical, FMRC approved, UL classified less-flammable Envirotemp FR3, in accordance with FMRC 3990. Fluid shall have a minimum open cup fire point of 350 degrees C and a minimum 5-day BOD (SM5210B) of 200 ppm. Manufacturer is to provide information on the transformers nameplate that it is "NON-PCB" along with "manufacturer's name and type of insulating fluid."

Primary Taps:

Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.

Externally operated no-load tap changer.

Provisions for locking handle in any position.

Coil Conductors: Copper windings, insulated with B-stage, epoxy coated, diamond pattern insulating paper, thermally cured under pressure.

Sound Level: In accordance with manufacturer’s standards.

ENCLOSURE:

In accordance with ANSI C57.12.28 requirements.

Welded carbon steel sealed transformer tank, with domed tank cover , and recessed stainless steel lifting eyes.

12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.

Corrosion Protection and Color: Base(s) and cabinet(s) of the transformer shall be corrosion resistant and shall be fabricated of steel. Provide insulating and corrosion resistance undercoating on base of transformer. Paint bases, cabinets, and tanks Munsell 7GY3.29/1.5 green. The Munsell color notation is specified in ASTM D1535.

TERMINAL COMPARTMENT:

General: ANSI C57.12.28, enclosed high and low voltage assemblies side by side, , bolted to transformer tank.

Door:

Hinged door with stainless steel hinge pins and barrels

Door Bolts: Recessed, captive, penta head type.

Removable front sill to facilitate rolling or skidding over conduit stub ups.
Floating lock pocket.

High Voltage Assembly:

Deadfront in accordance with ANSI C57.12.25 type construction.
Protective fuses.
High voltage bushings.
Transformer grounding pad.
Surge arrestors with barriers.
Parking stands.

Low Voltage Assembly:

Livefront in accordance with ANSI C57.12.25 type construction.
Low voltage bushings.
Grounding pad.
Stainless steel equipment nameplate.
Liquid level gauge.
Oil filling plug.
Drain valve with sampling device.
Dial type thermometer.
Pressure relief device, self-resealing with indicator.
Pressure-vacuum gauge.
Nameplate per Nameplate A, IEEE C57.12.00.

BUSHINGS:

High Voltage:

Deadfront Termination:

Universal bushing well rated at 15 kV in accordance with ANSI 386.

Bushings externally clamped and front removable.

Rated for 200 amperes continuous, 95 kV BIL.

Standoff brackets located adjacent to bushings.

Low Voltage:

Molded epoxy bushing clamped to tank with 4 hole spade type terminals.

Rated 150 percent of continuous full-load current, 30 BIL, 600 volts.

HIGH VOLTAGE PROTECTION:

Combination Oil-Immersed Bayonet Expulsion and Current Limiting Fuses:

Accessibility:

Bayonet expulsion fuse accessible through primary compartment.

Current-limiting fuse accessible through tank handhole.

Expulsion Fuse for Low Current Faults: Interrupting capacity of 1,800 amperes rms asymmetrical.

Current Limiting for High Current Faults: Interrupting capacity of 50,000 amperes rms symmetrical.

Bayonet fuse externally replaceable with hot stick.

Bayonet fuse links shall be dual sensing for both high currents and high oil temperature in order to provide thermal protection to the transformer.

Coordinate transformer protection with expulsion fuse clearing low-current faults and current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse.

In order to eliminate or minimize oil spills, the bayonet fuse assembly shall include an oil retention valve inside the housing, which closes when the fuse holder is removed and an external drip shield.

Warning shall be conspicuously displayed within the high-voltage compartment cautioning against removing or inserting fuses unless the load-break switch is in the OPEN position and the tank ressure has been released.

Bayonet Fuse Assembly: 150 kV BIL.

Oil-Immersed Current-Limiting Fuses: NEMA C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified.

TANK GROUNDING PADS:

Low Voltage Compartment:

Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.

TAP CHANGER WARNING SIGN:

Red laminated plastic, engraved to white core.

Engrave to read DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

Mount above tap changer handle.

ADJUSTMENTS:

Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

PART 3 – EXECUTION

GENERAL:

Prepare subgrade for utility pad mounted transformer as specified in Section 02319, SUBGRADE PREPARATION, paragraph “Prepared Subgrade for Roadway, Embankment and Structures.”

Secure to mounting pads with anchor bolts.

Install plumb and longitudinally in alignment with pad or adjacent building wall.

Ground neutrals and enclosures in accordance with applicable codes and as shown on the Drawings.

CONSTRUCTION QUALITY CONTROL:

In accordance with Section 16080, ELECTRICAL TESTING.

END OF SECTION 16270-1

SECTION 16312 – OVERHEAD ELECTRICAL DISTRIBUTION Sched. A

PART 1 – GENERAL

REFERENCES:

The following is a list of standards which may be referenced in this section:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2	National Electrical Safety Code
ANSI C12.7	Watthour Meter Sockets
ANSI C12.10	Watthour Meters
ANSI C12.11	Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV (0.6 kV NSV Through 69 kV NSV)
ANSI C12.13	Electronic Time-of-Use Registers for Electricity Meters
ANSI C12.15	Electricity Metering Solid-State Demand Registers for Electromechanical Watthour Meters
ANSI C12.16	Solid-State Electricity Meters
ANSI C29.2	Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	Wet-Process Porcelain Insulators - Strain Type
ANSI C29.5	Wet-Process Porcelain Insulators - Low- and Medium-Voltage Types
ANSI C29.6	Wet-Process Porcelain Insulators, High-Voltage Pin Type
ANSI C29.7	Wet Process - Porcelain Insulators - High-Voltage Line-Post Type
ANSI C37.42	High Voltage Expulsion Type Distribution Class Fuses, Cutouts, Fuse Disconnecting Switches and Fuse Links
ANSI C57.12.20	Transformers – Overhead Type Distribution Transformers, 500 kVA and Smaller: High-Voltage, 34500 Volts and Below; Low-Voltage, 7970/13800Y Volts and Below
ANSI C57.12.28	Switchgear and Transformers - Pad-Mounted Equipment - Enclosure Integrity
ANSI O5.1	Wood Poles

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	Forged Fittings, Socket-Welding and Threaded
ASME D3487	Mineral Insulating Oil Used in Electrical Apparatus

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	All Timber Products - Preservative Treatment by Pressure Processes
AWPA C4	Poles - Preservative Treatment by Pressure Processes
AWPA C25	Crossarms, Pressure Treatment

ASTM INTERNATIONAL (ASTM)

ASTM A53	Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless
ASTM A153/A153M	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A475	Zinc-Coated Steel Wire Strand
ASTM B1	Hard-Drawn Copper Wire
ASTM B2	Medium-Hard-Drawn Copper Wire
ASTM B3	Soft or Annealed Copper Wire
ASTM B8	Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B228	Concentric-Lay-Stranded Copper-Clad Steel Conductors
ASTM B231/231M	Concentric-Lay-Stranded Aluminum 1350 Conductors
ASTM B232/B232M	Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACSR)
ASTM B397	Concentric-Lay-Stranded Aluminum-Alloy 5005-H19 Conductors
ASTM B399/B399M	Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors
ASTM D117	Electrical Insulating Oils of Petroleum Origin

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 48	Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765kV
IEEE C37.30	High-Voltage Switches
IEEE C37.60	Overhead, Pad Mounted, Dry Vault, and Submersible Automatic Circuit Reclosers and Fault Interrupters for AC Systems
IEEE C37.63	Overhead, Pad Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizers for AC Systems
IEEE C57.12.00	General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEEE C57.12.90	Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and Guide for Short-Circuit Testing of Distribution and Power Transformers
IEEE C57.13	Instrument Transformers
IEEE C62.11	Metal-Oxide Surge Arrestors for Alternating Current Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 70	Standard for Non-shielded Power Cables Rated 2000V or Less for the Distribution of Electrical Energy

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	Electrical Power Distribution Equipment and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electrical Code

RURAL UTILITIES SERVICE (RUS)

RUS 202-1	List of Materials Acceptable for Use on Systems of RUS Electrification Borrowers
RUS 1728F-700	Wood Poles, Stubs, and Anchor Logs
RUS 1728H-701	Wood Crossarms (Solid and Laminated Transmission Timbers and Pole Keys)

UNDERWRITERS LABORATORIES INC. (UL)

UL 6	Rigid Metal Conduit
UL 510	Polyvinyl Chloride Polyethylene and Rubber Insulating Tape

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Conductors.
Insulators.
Wood poles and crossarms.
Utility vault (reference Section 16005, ELECTRICAL).
Cutouts.
Surge arrestors.
Guy strand and guards.
Anchors and anchor rods.
Ground rods.
Conduit.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Test Reports:

Acceptance checks and tests.
Ground resistance test reports.

Certificates:

Wood poles.
Wood crossarms.

DELIVERY, STORAGE, AND HANDLING:

Pole Line Material Storage:

Poles that will be stored longer than 2 weeks shall be stored on supports at least 1 foot aboveground in accordance with ANSI O5.1. Strength and spacing of supports, and manner of stacking shall produce no noticeable distortion in poles.

Construction hooks, tongs, or other sharp tools shall not be used on the treated portion of poles. Do not use pointed tools capable of producing indentations of more than 1 inch in depth. Nails and holes are not permitted in the top of poles.

Cable Inspection: Upon delivery to construction site, cable and reels shall be inspected for shipping damage such as:

Marks caused by improper lifting equipment or techniques.

Breaks or cuts in outer covering.
Damaged jacket or insulation.
Reel damage from mishandling.

Cable Testing: Upon delivery to construction site and prior to installation, Construction General Contractor shall perform DC over-potential tests on new cable.

Cable Reel Storage:

Reels shall be stored with flanges resting on hard surface or pallets to prevent sinking into the ground.
Reel flanges shall not touch cable on other reels.
Reels shall not be stored on their sides; they shall be stored with reel axis horizontal.
Cable ends shall be taped or capped to prevent entrance of moisture.
Material stored at construction site shall be located to prevent damage from weather and adjacent construction operations.

Cable Reel Handling:

Slings and forklifts shall not contact cable or protective covering.
A spreader bar shall be used when lifting reel with bar and sling.
Reels shall not be dropped.

PART 2 – PRODUCTS

MATERIAL AND EQUIPMENT:

Consider materials specified herein or shown on Drawings which are identical to materials listed in RUS 202-1 as conforming to requirements.

WOOD POLE:

Machine trimmed by turning western red cedar, cut from live timber in accordance with ANSI O5.1.

Poles shall be butt-treated by manufacturer in accordance with AWPA C7, using AWPA P8 and P9 preservatives.

Each pole shall be given single top cut at 30-degree angle with normal to axis of pole and at right angles to sweep. Gains shall be cut so roof will be at right angles to line and sweep of pole will be in line. Roofs and gains shall be brush-treated by manufacturer with specified preservative. Each gain shall fit crossarm tightly. Boltholes shall not be more than 1/16 inch oversize.

Quality of each pole shall be ensured with “WQC” (wood quality control) brand on each piece, or by an approved inspection agency report.

WOOD CROSSARM:

Conform to RUS 1728H-701. Straight-gained Douglas fir, free from twists to within 0.1 inch per foot length, with bends and twists in one direction.

Pressure treat crossarms with pentachlorophenol, chromated copper arsenate (CCA), or ammoniacal copper arsenite (ACA).

Treatment shall conform to AWPA C25.

Crossarm Braces: Provide wood crossarm braces as indicated.

HARDWARE:

Hot-dip galvanized, conforming to ASTM A153/A153M.

INSULATOR:

Provide wet-process porcelain insulators, which are radio interference free.

Line Post Type Insulators: ANSI C29.7, Class 4.

Suspension Insulators: ANSI C29.2, Quantity one per cable connection assembly, Class 4.

Spool Insulators: ANSI C29.3, Class 53-2.

Guy Strain Insulators: Porcelain, ANSI C29.4, Class 4, except provide fiberglass type when used with underground terminal or when other interference problems exist.

Pin Insulators: ANSI C29.5, Class 55-5.

OVERHEAD CONDUCTOR:

Conductor of bare copper, ASTM B1, ASTM B2, and ASTM B3, hard-drawn, medium-hard-drawn, and soft-drawn, ASTM B8, stranded, aluminum conductor steel reinforced (ACSR), ASTM B232/B232M, of size and type indicated.

GUYS:

Guy Strands: ASTM A475, extra-high strength, Class A or B, galvanized strand steel cable. Guy strand shall be 3/8 inch in diameter with ultimate breaking strength as shown on the Drawings. Provide guy terminations designed for use with the particular strand and developing at least the ultimate breaking strength of the strand.

Round Guy Guard: Vinyl or PVC material, yellow colored, 8-feet long, and shatter resistant at sub-zero temperatures.

Guy Attachment: Thimble eye.

ANCHOR AND ANCHOR ROD:

Anchor shall be concrete cone anchor presenting holding area indicated on Drawings as a minimum. Anchor rod shall be twin thimble-eye, 3/4-inch diameter by 9-feet long. Anchor and anchor rod shall be hot-dip galvanized.

GROUNDING:

Rod:

Copper clad steel at least 3/4 inch in diameter and 10 feet long.
Hard, clean, smooth, continuous, surface throughout length of rod.
Die-stamp each near top with name or trademark of manufacturer and length of rod in feet.

Wire:

Soft drawn copper wire ground conductor, minimum No. 4 AWG.

Ground wire protector may be either PVC or half round wood molding. Wood molding shall be fir, pressure treated in accordance with AWPA C25, or shall be cypress or cedar.

SURGE ARRESTOR:

IEEE C62.11, metal oxide, polymer housing, surge arrestor arranged for equipment mounting. RMS voltage rating shall be 18 kV. Arrestor shall be Heavy-Duty Distribution class.

FUSED CUTOUT:

Nonloadbreak open type construction rated 100 amperes, 15 kV, 110 kV BIL, with a minimum 10,000 amperes symmetrical interrupting rating conforming to ANSI C37.42.

Fuses shall be of "6T" Link type, size as specified by Fluor Hanford Electric Utility (FHEU). Fuse cutouts shall be equipped with mounting brackets suitable for the indicated installations.

CONDUIT RISER AND CONDUCTOR:

Rigid galvanized steel conduit conforming to UL 6. Provide conductors (600 volts and above) as specified in Section 16120, CONDUCTORS.

Porcelain Insulator Type Terminator:

Comply with requirements of IEEE 48, Class 1, except that requirements of design tightness test need not be met.

Shall not exude any insulating filler compound under either test or service.

Consist of porcelain insulator, copper cable connector-hoodnut assembly and copper aerial lug as required, metal body and supporting bracket, sealed cable entrance, internal stress relief device for shielded cable, and insulating filler compound or material.

ELECTRICAL TAPES:

Tapes shall be UL listed for electrical insulation and other purposes in wire and cable splices. Termination, repair, and miscellaneous purpose electrical tapes shall comply with UL 510.

CAULKING COMPOUND:

Compound for Sealing Conduit Risers:

Puttylike consistency, workable with hands at temperatures as low as 35 degrees F.
Shall not slump at 300 degrees F and shall not harden materially when exposed to air.
Shall readily caulk or adhere to clean surfaces of material with which it is designed to be used.
Shall have no injurious effects upon workmen or upon materials.

PART 3 – EXECUTION

INSTALLATION:

General: Provide overhead pole line installation conforming to requirements of ANSI C2 for Grade C construction of overhead lines in medium loading districts and NFPA 70 for overhead services. Consider street, alleys, roads and drives "public." Pole configuration shall be as indicated on Drawings.

Pole Setting: Provide pole holes at least as large at top as at bottom and large enough to provide 4 inch clearance between pole and side of hole.

Pole Setting Depths

Length of Pole (feet)	Setting in Soil (feet)	Setting in Solid Rock (feet)
20	5.0	3.0
25	5.5	3.5
30	5.5	3.5
35	6.0	4.0
40	6.0	4.0
45	6.5	4.5
50	7.0	4.5
55	7.5	5.0
60	8.0	5.0

Setting in Soil, Sand, and Gravel: Applying where the following occurs:

Where pole holes are in soil, sand, or gravel or any combination of these.
Where soil layer over solid rock is more than 2 feet deep.
Where hole in solid rock is not substantially vertical.
Where diameter of hole at surface of rock exceeds twice the diameter of pole at same level. At corners, dead ends, and other points of extra strain, poles 40 feet or more long shall be set 6 inches deeper.

Backfill: Thoroughly tamp pole backfill for full depth of hole and mound excess fill around pole.

Setting Poles: Set poles so that alternate crossarm gains face in opposite directions, except at terminals and dead ends where gains of last two poles shall be on side facing terminal or dead end. On unusually long spans, set poles so that crossarm comes on side of pole away from long span. Where pole top pins are used, they shall be on opposite side of pole from gain, with flat side against pole.

Alignment of Poles: Set poles in alignment and plumb except at corners, terminals, angles, junctions, or other points of strain, where they shall be set and raked against strain. Set not less than 2 inches for each 10 feet of pole length above grade, nor more than 4 inches for each 10 feet of pole length after conductors are installed at required tension. When average ground run is level, consecutive poles shall not vary more than 5 feet in height. When ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid highest and lowest ground points. If it becomes necessary to shorten pole, a piece shall be sawed off top and shall be treated and capped. Holes shall be dug large enough to permit proper use of tampers to full depth of hole.

Pole Cap: Provide plastic pole caps with 1/4-inch sealing rings and 4 nailing tabs. Fill sealing area with either a bituminous, elastigum roof cement, or an acceptable preservative paste to level of sealing ring to eliminate possibility of condensation. Place on pole top and nail each tab down with 1-1/4-inch nail. Pole caps are not necessary for ACA/CCA treated poles, unless they are shortened.

Cutting of Wood Poles: Where new gains or holes are required, paint gains with preservative compound as recommended by the pole manufacturer. Plug unused or abandoned holes using treated wood dowel pins.

Do not cut the tops of wood poles, except under very exceptional conditions, and only upon approval of Construction Manager. If cutting is deemed necessary, pole top shall be capped. Do not cut butt of wood poles.

Anchor and Guy: Place anchor in line with strain. Length of guy lead (distance from base of pole to top of anchor rod) shall be as indicated.

Setting Anchor: Set anchor in-place with anchor rod aligned with, and pointing directly at, guy attachment on pole with anchor rod projecting 6 to 9 inches out of ground to prevent burial of rod eye.

Setting Guy Strand:

Complete anchor and guy installation, dead end to dead end, and tighten guy before wire stringing and sagging is begun on that line section.

Provide strain insulator at a point on guy strand 8 feet, minimum, from ground and 6 feet, minimum, from surface of pole.

Hardware: Provide hardware with washer against wood and with nut and lock nut applied wrench tight. Provide locknut on threaded hardware connection. Locknut shall be M-F style and not palnut style.

Grounding:

Conform to ANSI C2. Ground fused switches and lightning arrestors. Bond together pole line hardware separated by less than 2 inches.

Ground Rod Connection:

On pole lines by exothermic weld or by using compression connector for ground wire or wire to rod connection.

Exothermic welds strictly in accordance with manufacturer's written recommendations.

Welds which have puffed up or which show convex surfaces indicating improper cleaning, are not acceptable.

No mechanical connectors are required at exothermic weldments.

Compression connector shall be type that uses hydraulic compression tool to provide correct pressure.

Provide tools and dies recommended by compression connector manufacturer.

Embossing die code or similar method shall provide visible indication that connector has been fully compressed on ground wire.

Grounding and Grounded Connections:

Where no primary or common neutral exists, surge arrestors and frames of equipment operating at over 750 volts shall be bonded together and connected to a dedicated grounding electrode.

Where no primary or common neutral exists, transformer secondary neutral bushing, secondary neutral conductor, and frames of equipment operating at under 750 volts shall be bonded together and connected to a dedicated grounding electrode.

When a primary or common neutral exists, connect all grounding and grounded conductors to common grounding electrode.

Protective Molding: Protect grounding conductors that are run on surface of wood poles by wood molding or plastic molding of equal mechanical strength extending from ground line throughout communication and transformer spaces.

Conductors: Prevent nicking, kinking, gouging, flattening, or otherwise deforming or weakening conductor or impairing its conductivity. Remove damaged sections of conductor and splice conductor.

Splices: Conductor splices, as installed, shall exceed ultimate rated strength of conductor and shall be of type recommended by conductor manufacturer. No splice shall be permitted within 10 feet of a support.

Ties: Provide ties on pin insulators tight against conductor and insulator and ends turned down flat against conductor so that no wire ends project.

Reinstalling: Existing conductors to be reinstalled or resagged shall be strung to "final" sag table values indicated for particular conductor type and size involved.

New Installation: String new conductors to "initial" sag table values indicated for conductor type and size of conductor and ruling span indicated.

Aluminum Protection: Protect ACSR conductors by armor rod at pin insulators and by flat aluminum wire at attachments made of galvanized or coated iron or steel.

Fittings: Dead end fittings, clamp or compression type, shall conform to written recommendations of conductor manufacturer and shall develop full ultimate strength of conductor.

Aluminum Connections: To copper or other material using only splices, connectors, lugs, or fittings designed for that specific purpose.

Riser: Secure conduit on pole by two hole galvanized steel pipe straps spaced no more than 10 feet apart and within 3 feet of any outlet or termination. Ground metallic conduit.

CONSTRUCTION QUALITY CONTROL:

Wood Crossarm Inspection: Furnish inspection report from independent inspection agency, approved by the Tank Farm Contractor, stating that offered products comply with applicable AWPA and RUS standards. The RUS approved Quality Mark "WQC" on each crossarm will be accepted, in lieu of inspection reports, as evidence of compliance with applicable AWPA treatment standards.

Acceptance Checks and Tests:

Notify Fluor Hanford Electrical Utility (FHEU) 5 working days prior to start of checking and testing. FHEU will test 15 kV cables and transformers.

Perform in accordance with manufacturer's recommendations and include the following visual and mechanical inspections, and electrical tests, performed in accordance with NETA ATS.

Grounding System:

Visual and Mechanical Inspection: Inspect ground system for compliance with Drawings and Specifications.

Electrical Tests: Perform ground-impedance measurements utilizing fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of single ground rod, perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. Instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate ground value of ground rod or grounding systems under test.

Report:

Before energizing electrical equipment, submit the measured ground resistance of grounding system.

Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at time measurements were made.

Devices Subject to Manual Operation: Operate at least three times, demonstrating satisfactory operation each time.

Follow-Up Verification: Upon completion of acceptance checks and tests, show, by demonstration in service, that circuits and devices are in operating condition and properly performing intended function.

END OF SECTION 16312

SECTION 16440 – LOW VOLTAGE MOTOR CONTROL SCHED. B

PART 1 – GENERAL

UL COMPLIANCE:

Products manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL Listing Mark.

APPROVAL BY AUTHORITY HAVING JURISDICTION (AHJ):

As specified in Section 16005, ELECTRICAL.

ELECTRICAL DESCRIPTION OF WORK:

Provide the following 480-volt, three-phase, four-wire with ground, 600-amp service rated motor control centers in accordance with this Specification and Contract Drawings:

219A-LH-MCC-001 to be installed inside the Cell No. 1 Crest Pad Building 219A.

219E-LH-MCC-001 to be installed inside the Cell No. 2 Crest Pad Building 219E.

MCC(s) shall be provided with the following minimum features in accordance with this Specification and Contract Drawings:

Main Incoming Service Breaker, with service neutral terminal connection in main breaker section only.

Portable Generator Power Outlet Feeder Breaker and Kirk Key (ed) arrangement with main incoming service breaker.

Phase Loss and Reversal Protection Relay and Alarm Lighting.

Transient Voltage Surge Suppressor (TVSS).

Volt and Current Meters and Selector Switches.

Lighting Panel.

Lighting Panel Transformer.

NEMA 1 Size Motor Starters (incorporating: breaker, control power transformer, fuses, contactor, overloads, indicators, control switches, elapsed time meter, terminal strips, wiring, and locking mechanism).

NEMA Feeder Breakers.

Three Sections.

Time Delay and Magnetic Control Relays.

Interlocking control relays, terminals, and lining assembled together in unit compartment.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Product Data:

Itemized bill-of-material.
Descriptive information.
Dimensional drawings.
Conduit entrance locations.
Bus data.

Protective Devices: Copies of time-current characteristics.

Operational description.
Anchoring instructions and details.

Typed Tabulation:

Motor name; tag (equipment) numbers as shown on Drawings.
Motor horsepower.
Nameplate full load current.
Measured load current and voltage.
Heater catalog number.
Protective device trip settings.
Attach above typed, tabulated data to a copy of starter manufacturer's overload selection tables for the starters provided.

Control Diagrams:

NEMA ICS 2, Section 322.08 Type I.
Wiring Type B.
In addition to standard NEMA control diagrams, provide the following:
Remote control devices.
Remote indication and/or pilot lights.
Interconnections and interlocking circuits between starter and remote equipment.
Remote sensors.
Tag numbers associated with all control devices and equipment.
One-line diagrams.
Schematic (elementary) diagrams.
Outline diagrams.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Manufacturer's installation instructions.

Operation and maintenance data, including recommended preventative maintenance tasks and frequencies for performance of those tasks.

Submit documentation and test results for construction quality control testing.

PACKING AND SHIPPING:

Shipping Splits: Established by Construction Subcontractor to facilitate ingress of equipment to final installation location within the building.

PART 2 – PRODUCTS (REFERENCE SECTION 16005, ELECTRICAL)

MANUFACTURERS:

Square D.
Cutler-Hammer.
General Electric.
Allen-Bradley.

MOTOR CONTROL:

General:

Like Items of Equipment: End product and responsibility of one manufacturer.

Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

Controllers: NEMA ICS 2, Class B.

Electronic Overload Protection:

Programmable solid-state electronic overload relay with integral CT(s) for monitoring three-phase current and voltage, thereby providing motor overload, phase reversal and phase loss protection. In the event of an alarm condition, electronic overload relay will de-energize fail safe alarm contact to motor control circuit.

Ratings:

Voltage Range (L1, L2-L3): 480 volts 50/60 Hz.

Current Range: Specific range compatible with motor FLA operation.

Power Consumption: 10 watts.

Trip Circuit: Form C SPDT (N.O and N.C) contacts, 5 amps 120 volts.

Measurements: Voltage, current, and timing.

Relay Trip: Standard Class 20.

Manual Reset.
Mount within starter unit.

Manufacturer:

Square D.
Allen-Bradley.
General Electric.
Cutler-Hammer.

Control Transformer:

Two winding, 120-volt secondary, primary voltage to suit.
Two current-limiting fuses for primary circuit.
One fuse in secondary circuit.
Mount within starter unit.
Suitable for use with 75 degrees C copper wire at full NFPA 70, 75 degrees C ampacity.
Lifting lugs on all equipment and devices weighing over 100 pounds.

Operating Conditions:

Ambient Temperature: Maximum 40 degrees C.

Equipment to be fully rated without any derating for operating conditions listed in Section 16005, ELECTRICAL.

Enclosures: In accordance with NEMA 250 and ANSI C57.12.28.

Equipment Finish:

Electrocoating process applied over a rust-inhibiting phosphated base coating.

Exterior Color: Manufacturer's standard.

Manually Operated Starter, Fractional Horsepower:

Rating: 16 amperes continuous at 277 volts maximum, or horsepower rated for the voltage and horsepower of the load served.

Single-phase, nonreversing, full voltage with overload protection.

Toggle operated.

Enclosure: Reference Section 16005, ELECTRICAL, Article ENVIRONMENTAL CONDITIONS.

Pilot LED Light: Red.

Handle guard/lock-off attachment.

Combination Full-Voltage, Magnetic Starter:

Rating: Hp rated at 600 volts, UL labeled for 42,000 amperes fault current withstand capacity with overload protection.

Three-phase, nonreversing, full voltage.

Control: HAND/OFF/AUTO selector switch.

Disconnect Type: Motor circuit protector.

Enclosure: Reference Section 16005, ELECTRICAL, Article ENVIRONMENTAL CONDITIONS.

Pilot LED Lights: Red—ON and Green—OFF.

Padlockable operating handle.

KIRK KEY INTERLOCKS:

Provide Kirk Key interlocks for one main and one portable generator plug breaker arrangement in each MCC.

Provide engraved plate on MCC which describes Kirk Key breaker arrangement and operation as described herein.

Operation:

One unique key available for MCC main and portable generator breaker locks (i.e., Kirk keys for additional MCC(s) shall not be identical).

One of the two breakers CLOSED at any one time.

Breaker must be opened before key can be removed and inserted.

Key must be inserted and operated before breaker can be CLOSED.

MOTOR CONTROL CENTERS:

General:

Motor Control Center to be manufactured and provided as a complete UL-approved assembly that includes the following major components specified under this section and Section 16005, ELECTRICAL:

Motor starters with electronic overload protection relays.
Feeder and main breakers.
Power monitoring.
Lighting and power distribution panelboard.
Lighting and power distribution stepdown transformer.

Transient Voltage Surge Suppressor (TVSS).
Interlocking control relays.
In accordance with NEMA ICS 2, UL 845, and UL 508/508A.

Voltage Rating: 600 volts.

Short Circuit Rating: 42,000 minimum amperes rms symmetrical for entire motor control center as a complete assembly.

All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted.

NEMA ICS 2, Section 322.08.

Class: I.

Type: B.

Wire remote control and signal circuits to separate terminal board in each motor starter compartment.

Enclosure:

Type: NEMA 250 Type 12 unless otherwise rated.

Vertical Section Dimensions: 90 inches high, 20 inches wide, 20 inches deep.

Construction:

Sheet steel reinforced with channel or angle irons.

Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.

Removable top cover plates and bottom cover plates.

Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.

Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.

Vertical Wiring Compartment: Full height, isolated from unit starters with separate door.

Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.

Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.

External disconnect handles, padlockable in OFF position.

Cable Entrance: Incoming service enters from bottom; control and feeder circuits enter from top and bottom.

Bus:

Horizontal Power Bus:

Three-phase tin-plated, fully insulated, copper, entire width of control center, rated 600 amperes.
Construct to allow future extension of additional sections.
Pressure type solderless lugs for each incoming line cable.
Isolated from top horizontal wireway.
Provide Belleville washers on bus connection bolts.

Vertical Power Bus:

Three-phase tin-plated, fully insulated, copper, full height of section, rated 300 amperes.

Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.

Insulated and isolated barrier complete with shutters.

Provide Belleville washers on bus connection bolts.

Neutral Bus: 50 percent neutral, copper-tin-plated main breaker section only.

Ground Bus:

Copper, tin-plated, 33 percent minimum of phase bus ampacity, entire width of control center.
Provide Belleville washers on bus connection bolts.

Bus Bracing: 42,000 minimum amperes rms symmetrical.

Motor Controller Unit:

Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in this section.

Construction:

Drawout combination type with stab connections for starters NEMA ICS, Size 4 and smaller.
Readily interchangeable with starters of similar size.
Pull-apart unit control wiring terminal boards on all units.

Starters:

NEMA ICS 2, Section 322.08 standard rating, except none smaller than NEMA ICS, Size 1.

Rating: Hp rated at 600 volts, UL labeled for 42,000 amperes fault current withstand capacity with overload protection.

Three-phase, nonreversing.

Disconnect Type: Thermal magnetic as shown. Motor circuit protector may be substituted, properly sized and adjusted.

Combination Full Voltage, Magnetic Starter:

Control: ON/OFF/AUTO selector switch. As shown.

Pilot LED Lights: Red—ON; Green—OFF.

Padlockable operating handle when de-energized.
Unit door interlocked to prevent opening when disconnect is in closed position.
Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

Disconnecting Device:

In each starter, control circuit disconnect to de-energize circuits in unit which are not de-energized by starter power disconnect device.

Padlockable in OPEN position.

Circuit Breaker:

Meeting the requirements of NEMA AB1 and UL 489.
Molded case with manufacturer's recommended trip setting for maximum motor protection.

Thermal-magnetic trip or magnetic trip only as shown.
Tripping indicated by operating-handle position.
Interrupting capacity required for connection to system with short circuit capacity indicated.

Motor Overload, Phase Reversal and Loss Protection:

Programmable solid-state electronic overload relay with internal CTs for monitoring three-phase current and voltage, thereby providing motor overload, phase reversal, and phase loss protection.

Make overload adjustments based upon motor FLA.

Make voltage adjustments based upon incoming voltage nominal readings.

Control Unit:

Disconnecting Device: Capable of de-energizing external source control circuits in unit.

Control Devices: As indicated and as specified in Section 16005, ELECTRICAL.

Control Wiring:

Minimum wire size No. 14 AWG copper.
Permanent sleeve type markers with wire numbers applied to each end of wires.
Terminate current transformer leads on shorting type terminal blocks.

Feeder Unit and Main Protective Device:

Construction: As specified in paragraph Motor Controller Unit.

Incoming Service Feeder: Cable entering section at bottom.

Molded Case Circuit Breaker:

In accordance with NEMA AB1 and UL 489.

Main, feeder, and motor protective device.

UL labeled as suitable for service entrance.

Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.

Indicate tripping by operating-handle position.

Suitable for use with 75 degrees C copper wire at full NEC 75 degrees C ampacity.

Reset Timer:

Timing Method: Solid state with LCD display.

Mounting: Semi-flush, panel.

Contacts: 5-amp, 120-volt.

Manufacturers and Products:

Square D
Cutler-Hammer
General Electric

Magnetic Contactor:

UL listed.
Electrically operated, electrically held.

Main Contacts:

NEMA B600 contacts.
Electrically held.
Silver alloy with wiping action and arc quenchers.
NEMA Size 0 or 1 as required for the motor controller.
Three-pole.

Control: Two-wire.

One normally open and one normally closed auxiliary contact rated 10 amperes at 480 volts.

Manufacturers and Products:

Allen-Bradley
Square D Co.; Type F
Cutler-Hammer

Pushbutton, Indicating Light and Selector Switches:

Contact Rating: NEMA ICS 2, Type A600.

Selector Switch Operating Lever: Standard.

Indicating Lights: Push-to-test, LED, full voltage.

Pushbutton Color:

ON or START: Black.

OFF or STOP: Red.

Pushbuttons and selector switches lockable in OFF position where indicated.

Legend Plate:

Material: Aluminum.

Engraving: 11 characters/spaces on one line, 14 characters/spaces on each of two lines, as required, indicating specific function.

Letter Height: 7/64 inch.

Manufacturers:

Square D Co.
Cutler-Hammer
General Electric.
Allen-Bradley

Nameplates:

Provide nameplates per Hanford standards.
Laminated plastic; white, engraved to black core.
Provide for each motor control center and each unit.
Engrave with inscription shown on single-line diagram.
Provide blank nameplates on spaces for future units.
Attach with stainless steel panhead screws on face of control center.

Factory Testing: NEMA ICS 1, Section 109, or UL 486A if not specified by the manufacturer.

PART 3 – EXECUTION

INSTALLATION:

Install equipment in accordance with NEMA ICS 2.3, Submittal Drawings, and Manufacturer's Instructions and Recommendations.

Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions. Reference Section 13122, METAL BUILDING SYSTEMS, Part 2, Article DESIGN LOADS, for information on seismic loading. Install suitable braces from MCC to building structural members for seismic support.

Install equipment plumb and in longitudinal alignment with pad or wall.

Coordinate terminal connections with installation of secondary feeders.

Grout mounting channels into floor or mounting pads.

Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

CIRCUIT BREAKERS (MAGNETIC-TRIP-ONLY):

Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
Adjust to approximately 11 times motor rated current in accordance with NEC 430-52.
Determine motor rated current from motor nameplate following installation.

OVERLOAD RELAY:

Select and install overload relay settings after the actual nameplate full-load current rating of motor has been determined.

MOTOR DATA:

Provide typed, self-adhesive label attached outside each motor starter enclosure door displaying the following information with plastic black and white lettering, minimum 1/2-inch size:

Motor served by tag number and equipment name.
Nameplate horsepower.
Motor code letter.
Full load amperes.
Service factor.
Installed overload relay heater catalog number.

CONSTRUCTION QUALITY CONTROL:

In accordance with Section 16080, ELECTRICAL TESTING.

MANUFACTURER’S SERVICES:

Furnish manufacturer’s representative in accordance with Section 01640, MANUFACTURERS’ SERVICES, for the following services at jobsite for minimum person-days listed below, travel time excluded:

1 person-day for installation assistance, and inspection of installation.
1 person-day for functional and performance testing.

END OF SECTION 16440

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