Specifications

Issued for Permit

PDX Fuel Company, LLC

PDX Facility Improvements

Project No. 153929

12/21/2023

Specifications

prepared for

PDX Fuel Company, LLC

PDX Facility Improvements
Portland, OR

Project No. 153929

12/21/2023

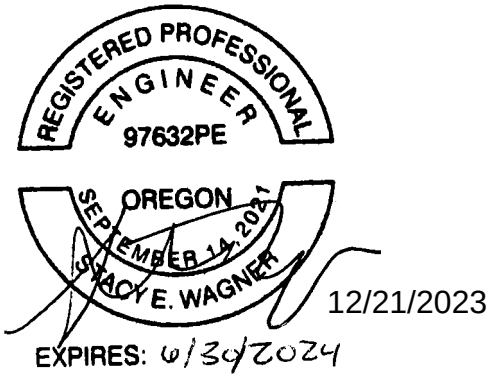
prepared by

Burns & McDonnell Engineering Company, Inc.

CERTIFICATION

I hereby certify, as a Professional Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

CIVIL ENGINEER



Stacy E. Wagner
BMcD Civil Engineer, P.E.

Date: 12/21/2023

CERTIFICATION

I hereby certify, as a Professional Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

MECHANICAL ENGINEER - FUELING

Douglas L. Woodward
BMcD Mechanical Engineer, P.E.

Date: 12/21/2023

CERTIFICATION

I hereby certify, as a Professional Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

ELECTRICAL ENGINEER

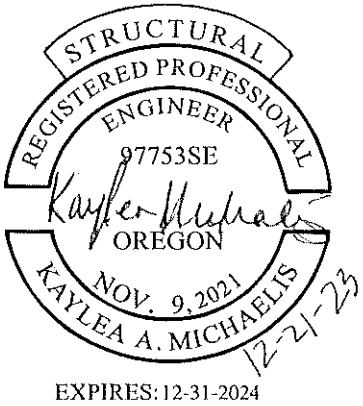
Timothy S. Renshaw
BMcD Electrical Engineer, P.E.

Date: 12/21/2023

CERTIFICATION

I hereby certify, as a Structural Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

STRUCTURAL ENGINEER



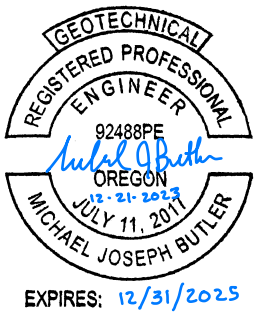
Kaylea A. Michaelis
BMcD Structural Engineer, S.E.

Date: 12/21/2023

CERTIFICATION

I hereby certify, as a Geotechnical Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

GEOTECHNICAL ENGINEER



Michael J. Butler
BMcD Geotechnical Engineer, G.E.

Date: 12/21/2023

CERTIFICATION

I hereby certify, as a Professional Engineer in the state of Oregon, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by PDX Fuel Company, LLC or others without specific verification or adaptation by the Engineer.

FIRE PROTECTION ENGINEER

William A. Clay
BMcD Fire Protection Engineer, P.E.

Date: 12/21/2023

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SECTION 01 25 05 – SUBSTITUTIONS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

1.02 RELATED REQUIREMENTS:

A. Submittals: Section 01 33 05

1.03 DEFINITIONS:

A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Changes in products, Materials, Equipment, and methods of construction required by the Contract Documents proposed by the Subcontractor after award of the Contract are considered to be requests for substitutions.

1.04 SUBMITTALS:

A. Substitution Request Submittal: Contractor will consider written requests from Subcontractor for substitution if received within 30 days after commencement of the Work. Requests received more than 30 days after commencement of the Work may be considered or rejected at the discretion of Contractor.

1. Submit requests in the form of and according to procedures required for Change Order Requests. Requests for substitution shall not be submitted in the form of a Request for Information (RFI).
2. Identify the Equipment or Material, the fabrication, or installation method to be replaced in each request. Include related Specification Section/Article and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    a. Statement indicating why specified product or method of construction cannot be provided.
    b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Contractor, Owner, and separate Subcontractors, that will be necessary to accommodate the proposed substitution.
    c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as performance, weight, size, durability, and visual effect.
    d. Product data, including drawings and descriptions of products and fabrication and installation procedures.
    e. Samples, where applicable or requested.
    f. A statement indicating the effect of the substitution on Subcontractor's construction progress schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on the overall Subcontract Times.
    g. An itemized estimate of costs that will result directly or indirectly from approval of the substitution, including:
        (1) A proposal of the net change, if any, in the Subcontract Amount.
        (2) Costs of resulting claims as determined in coordination with other subcontractors having work on the Project affected by the substitution.
    h. Subcontractor's certification that the proposed substitution conforms to requirements in the Contract Documents, will perform adequately the functions and achieve the results called for by the general design, is similar in substance to that specified, and is suitable for same use as that indicated and specified.

i. Subcontractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

4. Contractor's Action: If necessary, Contractor will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Contractor will notify Subcontractor of acceptance or rejection of the substitution within two weeks of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance will be in the form of a Change Order.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS:

A. Conditions: Contractor will receive and consider Subcontractor's request for substitution when one or more of the following conditions are satisfied, as determined by Contractor. If the following conditions are not satisfied, Contractor will return the requests without action except to record noncompliance with these requirements.
   1. Extensive revisions to the Contract Documents are not required.
   2. Proposed changes are in keeping with the general intent of the Contract Documents.
   3. The request is timely, fully documented, and properly submitted.
   4. The specified product or method of construction cannot be provided within the Subcontract Times. Contractor will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
   5. The requested substitution offers Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Contractor for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
   6. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where Subcontractor certifies that the substitution will overcome the incompatibility.
   7. The specified product or method of construction cannot be coordinated with other materials and where Subcontractor certifies that the proposed substitution can be coordinated.
   8. Subcontractor certifies that the proposed substitution provides the warranty required by the Contract Documents .

B. Contractor's review and acceptance of Submittals shall not relieve Subcontractor from responsibility for any variation from the requirements of the Contract Documents. Contractor's acceptance of Submittals not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval of a substitute. Acceptance by Contractor shall not relieve Subcontractor from responsibility for errors or omissions in the Submittals.

PART 3 - EXECUTION - NOT APPLICABLE

END OF SECTION 01 25 05

SECTION 01 31 00 – CONSTRUCTION ADMINISTRATIVE CONTROLS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. Requests for Information (RFIs).
   2. Construction Coordination and Meetings.
   3. Subcontractor Schedule, Progress, and Reports.
   4. Additional Work.
   5. Payments and Invoicing.
   6. Quality Assurance / Quality Control / Records.

B. Related Work Specified Elsewhere:
   1. Section 012505 – Substitutions
   2. Section 013305 – Submittals
   3. Section 017805 – Closeout
   4. Project Construction Quality Assurance Program

PART 2 - REQUESTS FOR INFORMATION (RFI)

2.01 PROCEDURE

A. Procedure: Promptly on discovery of the need for interpretation of the Contract Documents, prepare and submit an RFI with the content specified.
   1. RFIs shall originate with Subcontractor. RFIs submitted by entities other than Subcontractor will be returned with no response.
   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Subcontractor's Work or work of lower-tier subcontractors.
   3. RFIs shall be submitted on an Contractor-approved form.

B. Content of the RFI: Include a detailed, description of item needing interpretation and the following:
   1. Project name.
   2. Date.
   3. Subcontract number and title.
   4. RFI number, numbered sequentially.
   5. Specification Section number, revision/date, title and related paragraphs, as appropriate.
   6. Drawing number, drawing revision, and detail references, as appropriate.
   7. Field dimensions and conditions, as appropriate.
   8. Subcontractor's suggested solution(s). If Subcontractor's solution(s) impact the of Schedule of Work or the Subcontract Amount, Subcontractor shall state the impact(s) in the RFI.
   9. Attachments: Include drawings, descriptions, measurements, photos, product data, shop drawings, and other information necessary to fully describe items needing interpretation.

C. Contractor's Action: Contractor will review each RFI, determine action required, and return it. Allow seven (7) days for Contractor's response for each RFI. RFIs received after 1:00 p.m. local time will be considered as received the following working day.
   1. Multiple RFIs addressing similar or identical issues may be addressed by Contractor with a single broad response.
   2. Contractor's action may include a request for additional information, in which case Contractor's time for response will start again upon Subcontractor's response and resubmittal.
   3. If Subcontractor believes the RFI response warrants change in the Schedule of Work or the Subcontract Amount, notify Contractor consistent with the notification terms of the Subcontract Agreement.

4. On receipt of Contractor's action, promptly distribute the RFI response to affected parties. Review response and notify Contractor within three (3) days if Subcontractor disagrees with response.

PART 3 - CONSTRUCTION COORDINATION AND MEETINGS

3.01 COORDINATION:

A. Each Subcontractor shall:
   1. Participate in coordination requirements. Certain areas of responsibility will be assigned to a specific subcontractor.
   2. Coordinate its construction operations with those of other subcontractors, Contractor, Owner, and other entities to ensure efficient and orderly installation of each part of the Work.
   3. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   4. Make adequate provisions to accommodate items scheduled for later installation.
   5. Where availability of space is limited, coordinate installation of different components to allow optimum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.

B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of others to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of construction progress schedule.
   2. Installation and removal of temporary facilities and controls.
   3. Delivery and processing of Submittals.
   4. Progress meetings.
   5. Pre-installation conferences.
   6. Startup and adjustment of systems.
   7. Project closeout activities.

C. Subcontractor shall coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate subcontractors.

D. Subcontractor shall coordinate construction progress schedule with the schedule of values, list of subcontracts, schedule of Submittals, Material and Equipment procurement, progress reports, Application for Payment, and other required schedules and reports.

3.02 PROJECT MEETINGS:

A. General:
   1. The summary of meetings provided in this section is limited to pre-determined and recurring meetings which require Subcontractor’s active participation. The summary of meetings and agendas provided shall not be considered limiting or all inclusive for the project and adjustments shall be made by Contractor at its sole discretion to meet the specific conditions and requirements of the Project.
   2. Subcontractor shall be the primary responsible party for implementing and facilitating other meetings not listed in this section, however required, for the effective coordination, execution and management of Subcontractor’s safe and timely Work and fulfillment of its obligations per the Subcontract Agreement (i.e. weekly Tool-Box safety discussions, pre-task planning meetings, meetings with its lower-tier subcontractors, Subcontractor administrative meetings, etc.).
   3. Subcontractor is also required to participate in other meetings/reviews/discussions as requested by Contractor such as field progress measurement verification, resource planning, recovery scheduling, safety stand-downs, incident investigations, incident reviews, change management

review, submittal review, RFI review, critical lift plan review, interface coordination with other parties, administrative meetings, etc.

B. Preconstruction/Premobilization Conference:
   1. Purpose: Review items stated in the following agenda and establish a working understanding between the parties as to their relationships during performance of the Work.
   2. Time: Within fourteen (14) days prior to scheduled site mobilization, runs approximately ½ day excluding site orientation or trainings.
   3. Location of Meeting: At or near the Project Site.
   4. Facilitator: Contractor Project Manager.
   5. Required Attendees: Subcontractor's Project Manager, Site Safety Manager, Project Controls lead and Superintendent; Contractor Project Manager, Contractor's Construction Site Manager / Superintendent, Contractor's Assistant Project Manager/Subcontracts Administrator, others as requested by Contractor's Project Manager.

C. Project Controls Workshop Conference:
   1. Purpose: Review Subcontractor project controls responsibilities, requirements and deliverables and establish the Project Controls procedures, formats, and guidelines to be utilized by Subcontractor through execution of their scope of work.
   2. Time: Meeting to be held within (14) calendar days of award or as otherwise determined by Contractor (typically will require 1 full day depending on Work Package Scope, often held consecutively after the pre-contruction meeting when possible).
   3. Location: TBD.
   4. Facilitator: Contractor's Project Manager.
   5. Required Attendees: Subcontractor Project Controls Lead, Subcontractor Project Manager, Subcontractor responsible person in charge of the work; Contractor's Project Manager, Contractor Site Manager, Contractor Assistant Project Manager/Project Controls Assistant.

D. All-hands Safety Meeting:
   1. Purpose: Primary project safety meeting to discuss and recognize safety performance, promote safety awareness, renew all parties safety commitment and encourage postive safety behaviors.
   2. Time: Recurs weekly throughout duration of construction activities, runs 45 minutes or less.
   3. Location: Project Site - specific assembly point to be determined.
   4. Facilitator: Contractor Site Manager/Contractor Site Safety Manager.
   5. Required Attendees: All direct and indirect personnel working on the premises of the Project Site.
   6. Meeting Agenda/Topics:
      a. Sign-in/attendance.
      b. Review Project related safety topic(s).
      c. Discuss Project safety observations/audit results.
      d. Recognize achievements/outstanding acts/safety commitments.
   7. Reporting:
      a. File attendee logs.
      b. Document and file safety incentive distribution records (if applicable).

E. Construction Coordination Meeting:
   1. Purpose: High-level construction coordination meeting between all parties to Contractor involved in construction work on Site.
   2. Time: Weekly, day and time TBD, approximately 1 hour length.
   3. Location: Contractor Site Office Conference Room.

4. Facilitator: Contractor Construction Site Manager.
5. Mandatory Attendees: Contractor Supervisors; Subcontractor Lead Supervisor; Contractor's other subcontractor lead supervision on Site.
6. Optional Attendees: Owner and lower-tier subcontractors requested/approved by Contractor.

F. Weekly Subcontractor Meeting:
1. Purpose: Individual Subcontract work package meeting to review Subcontractor's schedule and progress, see Agenda/Topics below.
2. Time: Day and time TBD, recurs weekly, runs approximately 1 hour but may vary.
3. Location: Contractor Site Office.
4. Facilitator: Contractor Construction Site Manager.
5. Required Attendees: Subcontractor Superintendent and key representatives (all Subcontractor participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work); Contractor Superintendent; Contractor Assistant Project Manager/Project Controls Assistant.
6. Optional Attendees: Lower-tier subcontractors and Subcontractor representatives as approved/requested by Contractor; Contractor Safety Manager.

G. Site Safety Audit Meeting:
1. Purpose: Review by real-time observation the current safety and health conditions of the project site to assess performance, address any immediate issues, and proactively identify leading indicators.
2. Time: Time and frequency TBD (target weekly).
3. Location: Site Work Areas.
4. Facilitator: Contractor Construction Site Manager or Site Safety Manager.
5. Mandatory Attendees: Subcontractor representative, when requested, shall be required to participate. When possible, Contractor shall rotate its selection of Subcontractor companies and representatives to diversify input and observations.
6. Agenda: Contractor and selected Subcontractor representative shall cooperatively walk the Site and review conditions, housekeeping, safety devices, barriers, and safe work practices of the active Project Site. Observations are to be made collectively by the review team and without regard to individual companies or persons. The review team will assign values to consistent scoring criteria in order to provide compare performance scores throughout the project.
7. Reporting: Within (3) business days, Contractor will produce the assessment report and the results will be used as an aid in improving the safe management of the workplace. The site review and audit is planned to take approximately 1 hour per week.

H. Startup Coordination Meetings:
1. Contractor will conduct daily startup coordination meetings at the Site with subcontractors. Regular meetings will be held starting when Subcontractor's Work begins commissioning and startup activities and will continue until Substantial Completion is achieved. Subcontractor and its major lower-tier subcontractors shall attend and participate in the meetings.

PART 4 - SUBCONTRACTOR SCHEDULE, PROGRESS, AND REPORTS

4.01 SUMMARY:

A. This Part includes Subcontractor's project controls administrative, procedural, and submittal requirements concerning:
1. Subcontractor Schedule Requirements.
2. Subcontractor Field Progress Measurement System Requirements.
3. Reports.

B. Qualifications: Subcontractor shall designate an authorized representative who shall be responsible for the preparation and submittal of the entire project schedule, progress measurement, and monthly reports including all items specified and revisions to the schedule or supplemental completion schedules, as applicable or directed by Contractor.

C. The following table is provided as a summary outline of Subcontractor Schedule, Progress, and Report Deliverables required within this Part of the Specification:

Description	Initial Due	Update Due	Format
Schedule Submittals			
Preliminary Schedule	with Proposal	N/A	PDF
CPM Schedule	30 days after award or 14 days after Proj Ctrls Workshop Mtg	Weekly	PDF
Three-Week Look-Ahead	Preconstruction Mtg	Weekly	PDF
Submittal Schedule	7 days after award	Weekly	XLS or PDF
Reports			
Construction Progress Report	With first pay app	Monthly	PDF
Daily Field Report	First day on-site	Daily	PDF
Monthly Safety Work Hour Report	7th day of first month on-site	Monthly	PDF
Field Conditions Report	Upon discovery of instance	N/A	PDF
Special Reports	Within one day of occurrence	N/A	PDF

D. Report Period Cut-offs:
1. Daily: End of the working day or as specified herein.
2. Weekly: Saturday end of the day.
3. Monthly: Last Saturday of each calendar month.

4.02 SUBCONTRACT SCHEDULE REQUIREMENTS:

A. General Format:
1. Subcontractor CPM schedule .PDF printed submittals shall be in the form of a bar-chart (Gantt chart) containing the following information: Activity ID, Activity Description, Original Duration, Remaining Duration, Percent Complete, Planned/Actual Start Date, Planned/Actual Finish Date, variance to Baseline Planned Finish Date and Total Float.
2. All Subcontractor CPM schedule updates shall:
   a. Reflect the Baseline schedule planned start and finish dates for like activities as target bars represented as solid thin black bars below the current bar.
   b. Include an updated data date – must be current to the week schedule will be presented and discussed.
   c. Include updated activity starts and finishes per actual dates achieved since previous week update.
   d. Include updated remaining durations for all incomplete activities with respect to actual productivity achievements/limitations and future anticipated conditions.

e. Reflect all changes in Subcontractor work plan, sequence, and activity relationships since last progress update.
f. Include a brief narrative describing all assumptions, or changes in activity durations, CPM logic, or resource loading.

3. Contractor will have the right to decide the time, order, and priority in which the various portions of the Work shall be performed by Subcontractor and others. Subcontractor agrees to comply with any changes by Contractor in the Schedule of Work. Subcontractor shall give the Work the highest priority. No other activities of Subcontractor shall take precedence over the Work. Contractor retains control of schedule float.

B. Activities and Content shall:
1. Include an appropriate level of detail for executing and managing the Work.
2. Only be based on reasonable durations as agreed to by Contractor. Reasonable durations are those that allow the progress of activities to be accurately determined between update periods. Activity durations shall be generally limited to span a period of time less than the duration of time between two progress period updates (two weeks).
3. Incorporate Subcontractor Systems Turnover Schedule in accordance with Contractor's defined systems as bulk installation nears completion, no later than approximately 60% to 75% construction complete.
4. Utilize the Critical Path Method (CPM) with predecessor/successor relationships defined.
5. Include all interferences and impacts to Subcontractor's Work.
6. Display all major milestones for completion of Work as defined in the Contract Documents.
7. Contain all activities required to be completed by others in order for Contractor to complete the Work as defined in the Contract Documents.
8. Include the total Scope of Work, whether performed directly by Subcontractor, or contracted to a third party.
9. Display the Baseline schedule as a thin solid black bar under the current bar on the schedule Gantt chart.
10. Indicate completion in advance of date established for Substantial Completion, and allow time for Contractor's administrative procedures necessary for certification of Substantial Completion.
11. Include activities for sub-subcontract award, submittals, purchases, mockups, fabrication, sample testing, deliveries, installation, tests, inspections, adjusting, curing, startup and initial operation, performance and acceptance testing, commissioning.
12. Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, milestones per the Scope of Work, Substantial Completion, and Final Completion,.
13. Include all sub-subcontractor and sub-supplier activity details and schedules.
14. Include submittal activities related to the top five (5) critical paths of the Work or related to activities with less than (10) calendar days float. At minimum, include an activity for Subcontractor's initial submittal of all required information related to a specific task and a milestone activity for Contractor's approval of the submittal information, as predecessors required to the specific critical task.
15. Coordinate Submittals schedule with list of sub-subcontracts, the Schedule of Values, and Contractor's Integrated Project Schedule.
16. Subcontractor's Schedule shall include sufficient time within activity durations for the following:
a. Coordination with existing construction.
b. Use of premises restrictions.
c. Seasonal variations.
d. Environmental control.

C. Logic and calculations shall be based on:
1. Contiguous scheduling.

2. Total float calculations based upon finish dates compared to Contract milestones. Milestones in Contract Documents shall be constrained using "Finish On or Before" constraint using date defined in Contract Documents.
3. Retained logic.
4. Start-to-start lags calculated from actual start dates.
5. Percent complete and remaining duration not linked.
6. Based on Contractor's designated project work hours, calendar and planned holidays (5-day, 6-day, 7-day, etc).
7. Minimal use of open-ended activities and artificial constraint dates and no mandatory constraint dates and hammock activities without Contractor approval. Only one open-end is allowed for Start and one for Finish.

D. Subcontractor Schedule Deficiencies: Once notified in writing by Contractor to correct a schedule deficiency, which includes, but is not limited to late completion of activities, Subcontractor shall submit, within three (3) days, a recovery plan in the form of a revised CPM schedule. Subcontractor shall implement the approved recovery plan within three (3) days after written notification from Contractor. If Subcontractor fails to submit its recovery plan or fails to implement the plan within the stated time limits, Contractor may, at its sole discretion, exercise any and all remedies available under the Subcontract Agreement.

E. Subcontractor Change Orders/contract modifications: For each proposed contract modification and concurrent with its submission, Subcontractor shall prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall schedule. No schedule relief shall be granted without Contractor's formal approval by written Change Order and Action "A" approval Subcontractor's revised Baseline CPM schedule.

F. Subcontractor Schedule Reports and Submittals
   1. Preliminary Schedule:
      a. Purpose – Subcontractor's Preliminary Schedule will be reviewed in detail and discussed at the Project Controls Workshop Conference. It will be used as the basis for elaboration to develop Subcontractor's CPM schedule.
      b. Initially Due - Subcontractor shall submit for Contractor review per timing noted in table 6.01.C its Preliminary Project Schedule describing its planned operations from Subcontract Award through Substantial Completion.
   2. Subcontractor CPM schedule:
      a. Purpose – Subcontractor's CPM schedule will be used throughout execution of Subcontractor's Work to communicate, coordinate, manage, plan, and track Subcontractor's Work. Contractor's Action "A" approval of Subcontractor's initial CPM schedule submittal shall establish it as Subcontractor's approved Baseline CPM schedule. Baseline Project Schedule shall not be changed without Contractor's approval.
      b. Initially Due –Per earliest of timing noted in table 6.01.C, Subcontractor shall submit for Contractor approval a Critical Path Method (CPM) project schedule showing the sequence and the due date of technical Submittals, Contractor approvals, procurement, fabrication, contractual milestones, and all construction activities related to completion of the Work.
      c. Updates Due – Weekly; Subcontractor shall provide its CPM schedule progress update to Contractor by 8:00 am the business day prior to the weekly Construction Coordination Meeting.
   3. Three-Week Look-Ahead Schedule:
      a. Purpose - Subcontractor's Three-Week Look-Ahead Schedule shall be manpower loaded, and communicate all planned Work to be accomplished during the current week and the next two (2) week period in support of and in accordance with Subcontractor's CPM schedule. Planned and actual activities shall also be indicated for the previous week. Any

activities that are required to be accomplished by others that would impact and/or prevent Subcontractor from starting and/or accomplishing its planned Work shall also be displayed. The level of detail shall be sufficient to direct the efforts of the craft on a day to day basis.

b. Initially Due - Subcontractor shall submit its initial Three Week Look-Ahead at the Preconstruction Meeting.
c. Updates Due - Weekly; Subcontractor shall provide its Three-week Look-Ahead schedule update to Contractor by 8:00 am the business day prior to the weekly Construction Coordination Meeting.
d. If Subcontractor's CPM schedule contains 3-week look ahead sufficiently detailed as described, and at the approval of Contractor, Subcontractor may utilize Primavera P6 to produce their 3-week look-ahead.
e. Otherwise, Subcontractor shall submit its Three-Week Look-Ahead Schedule as a separate document in a Contractor Site Manager approved format.

4. Submittal Schedule and Log:
   a. Purpose – Used to manage timing of specific Subcontractor submittals and their respective status to support Subcontractor's CPM schedule. Subcontractor shall submit a Submittal Schedule/Log arranged in chronological order by dates required. Required dates shall include time required for review, resubmittal, and final approval as defined in SECTION 013305 - SUBMITTALS.
   b. Initially Due - Submit concurrently with Preliminary Schedule. Include Submittals required during at least the first (60) calendar days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
   c. Updates Due – Weekly; Provide Submittal Schedule/Log updates to Contractor by 8:00 am the business day prior to the weekly Construction Coordination Meeting.

4.03 REPORTS:

A. Daily Field Report: Subcontractor shall submit to Contractor's designated field representative prior to 9:00 a.m., starting from the day Subcontractor mobilizes on-site, a complete and signed Subcontractor's Daily Field Report form. The Daily Field Report shall contain the following information concerning events at Project Site for the preceding work day:
   1. List of lower-tier sub-subcontractors at Project Site.
   2. List of separate other Subcontractors (to Contractor) at Project Site.
   3. Count of Subcontractor's personnel at Project Site, and breakdown by craft, including any of Subcontractor's lower-tier subcontractors.
   4. Daily work hours.
   5. Subcontractor's construction equipment (owned and rentals) at Project Site (indicate whether in use or idle)
   6. Equipment and Material deliveries.
   7. Major work activites started.
   8. Major work activities continued.
   9. Major work activities completed.
   10. High and low temperatures, precipitation amounts, and general weather conditions.
   11. Accidents / Incidents / Near Misses.
   12. Meetings and significant decisions.
   13. Unusual events (refer to special reports).
   14. Stoppages, delays, shortages, and losses.
   15. Meter readings and similar recordings.
   16. Emergency procedures.

B. Monthly Safety Work Hour Report: Subcontractor shall provide a monthly safety Work hour report no later than the 7th day of each month. The cut-off date for safety Work hours will be as specified for

monthly reporting herein. This report shall indicate all Subcontractor and lower-tier subcontractor direct, and separately indirect, hours worked on site in the previous month and cumulative hours to date. This report shall advise for the month and cumulative to date safety statistics of OSHA Recordables, DART cases, DART Days, First Aids, Near Misses, Motor Vehicle Accidents, Environmental Incidents, Other Non-Classified Incidents, Report Only Incidents, TRIR, and DART rate.

C. Field Condition Reports: Promptly on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for information (RFI). Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

D. Special Reports:
   1. General: Submit special reports directly to Contractor within one (1) calendar day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.
   2. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project Site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Subcontractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Contractor in advance when these events are known or predictable.

PART 5 - QUALITY ASSURANCE, QUALITY CONTROL & CONSTRUCTION RECORDS

5.01 QA/QC SITE ADMINISTRATIVE REQUIREMENTS

A. Subcontractor shall utilize the Contractor Quality Assurance Program, including all forms. If Subcontractor wishes to utilize their own Project Specific Quality Control Program, it must be submitted to Contractor for review and approval before use. Even if Subcontractor’s Project Specific Quality Control Program is authorized for use, Contractor may still require the use of forms from the Contractor’s Quality Assurance Program.

B. Subcontractor shall perform quality control tests and procedures indicated by the Subcontract Documents. Subcontractor shall document and submit quality control activities to Contractor for review and approval as Work progresses.

C. Subcontractor shall assemble and maintain all testing and system turnover documentation required by the Subcontract or Contract Documents. At the completion of the Work, Subcontractor shall provide system turnover books complete with all required quality control records and testing documentation, complete with the appropriate Contractor, and Contractor, signatures, validating and documenting the completion of the Work.

D. Records shall be maintained at the Site during the course of Work by Subcontractor and transferred to Contractor upon request. Contractor reserves the right to review and audit records maintained at the Site on a regular or as-needed basis.

E. Contractor shall retain the right to audit and inspect, at reasonable times, Subcontractor 's Work, material, equipment, inspection procedures and quality control files to confirm compliance with the Contract Documents.

F. Subcontractor shall be responsible for the coordination and scheduling of required tests and inspections. Delays and/or rescheduling of Work due to the failure of Subcontractor to properly schedule, coordinate, or provide sufficient notice for inspections will not be cause for adjustments to the Subcontract Times or Subcontract Amount.

G. Subcontractor shall be responsible for maintaining a copy of all Contract Documents, including but not limited to all Specifications, RFIs, and Addenda, on-site.

H. Subcontractor shall be responsible to ensure current revisions of all Contract Documents are available to Subcontractor’s on-site staff and administered throughout the Work.

END SECTION 01 31 00

SECTION 01 33 05 – SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes definitions, descriptions, transmittal, and review of Submittals.

B. Related Work Specified Elsewhere:

1. Section 01 78 05 - Closeout

1.02 GENERAL INFORMATION:

A. Definitions:

1. Shop Drawings, product data, and Samples are technical Submittals prepared by Subcontractor, lower-tier subcontractors, manufacturers, or Suppliers and submitted by Subcontractor to Contractor as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Subcontractor's Work or needed to describe installation, operation, maintenance, or technical properties.

a. Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.

b. Product data includes standard printed information on materials, products, and systems; not custom-prepared for this Project, other than the designation of selections from available choices.

c. Samples include both fabricated and unfabricated physical examples of materials, products, and Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or (where indicated) for more detailed testing and analysis.

2. Informational Submittals are those technical reports, administrative Submittals, certificates, and guarantees not defined as Shop Drawings, product data, or Samples.

a. Technical reports include laboratory reports, tests, technical procedures, technical records, and Subcontractor's design analysis.

b. Administrative Submittals are those nontechnical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, Bonds, Project photographs, physical work records, statements of applicability, copies of industry standards, Project record data, security/protection/safety data, and similar type Submittals.

c. Certificates and guarantees are those Submittals on Equipment and Materials where a written certificate or guarantee from the manufacturer or Supplier is called for in the Specifications.

B. Quality Requirements:

1. Submittals such as Shop Drawings and product data shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible.

2. Documents submitted to Contractor that do not conform to specified requirements shall be subject to rejection by Contractor, and upon request by Contractor, Subcontractor shall resubmit conforming documents. Subcontractor's (or his lower-tier subcontractor's) failure to initially satisfy the legibility quality requirements will not relieve Subcontractor (or his lower-tier subcontractors) from meeting the required schedule for Submittals.

C. Submittal Completeness:

1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Contractor to review the information effectively.

2. Where standard drawings are furnished which cover a number of variations of the general class of Equipment, each drawing shall be annotated to indicate exactly which parts of the drawing apply

to the Equipment being furnished. Use hatch marks to indicate variations that do not apply to the Submittal. The use of "highlighting markers" will not be an acceptable means of annotating Submittals. Annotation shall also include proper identification of the Submittal permanently attached to the drawing.

3. Reproductions or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings. Subcontractor may use a reproduction of Contract Drawings for erection drawings to indicate information on erection or to identify detail drawing references. Whenever the Drawings are revised to show this additional Subcontractor information, Contractor's title block shall be replaced with a Subcontractor's title block, and Contractor's professional seal shall be removed from the drawing. The Subcontractor shall revise these erection drawings for subsequent Contractor revisions to the Contract Drawings.

D. Form of Submittals:
   1. Submittals and other Project documents shall be transmitted in electronic format as specified, with the following exceptions:
      a. Equipment instruction books and operating manuals shall be provided in paper copies in addition to specified electronic format.
   2. Electronic Format:
      a. Scanned Submittals and documents are not acceptable. Transmit Submittals and Project documents in:
         (1) Adobe *PDF files created directly from native electronic format, or
         (2) Contractor-approved equal.
         (3) Electronic submittal PDF files are not to be combined files or collections of files/drawings. Each drawing document must stand alone.
         (4) Each file will be right reading and oriented the same for all consecutive resubmissions.
      b. For any given Submittal, the filename and format shall be consistent for initial submission and subsequent revisions of the same. Use consistent naming convention throughout.
      c. Provide "as-constructed" Submittals, record documents, Equipment instruction books and operating manuals, and other documents in Adobe *PDF format as required and approved by Contractor.

1.03 TECHNICAL SUBMITTALS:

A. Items shall include, but not be limited to, the following:
   1. Manufacturer's specifications.
   2. Catalogs, or parts thereof, of manufactured Equipment.
   3. Shop fabrication and erection drawings.
   4. General outline drawings of Equipment showing overall dimensions, location of major components, weights, and location of required building openings and floor plates.
   5. Detailed Equipment installation drawings, showing foundation details, anchor bolt sizes and locations, baseplate sizes, location of Contractor's connections; and all clearances required for erection, operation, and disassembly for maintenance.
   6. Schematic diagrams for electrical items, showing external connections, terminal block numbers, internal wiring diagrams and one-line diagrams.
   7. Bills of material and spare parts list.
   8. Instruction books and operating manuals.
   9. Material lists or schedules.
   10. Performance tests on Equipment by manufacturers.
   11. Concrete mix design information.
   12. Samples and color charts.

13. All drawings, catalogs or parts thereof, manufacturer's specifications and data, samples, instructions, and other information specified or necessary:
    a. For Contractor to determine that the Equipment and Materials conform with the design concept and comply with the intent of the Contract Documents.
    b. For the proper erection, installation, operation, and maintenance of the Equipment and Materials which Contractor will review for general content but not for basic details.
    c. For Contractor to determine what supports, anchorages, structural details, connections, and services are required for the Equipment and Materials, and the effects on contiguous or related structures and Equipment and Materials.

B. Schedule of Submittals:
1. Prepare for Contractor's concurrence, a schedule for submission of all Submittals specified or necessary for Contractor's approval of the use of Equipment and Materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. Submit the schedule with the procurement schedule and construction progress schedule. Schedule submission of all Submittals to permit review, fabrication, and delivery in time so as to not cause a delay in the Work of Subcontractor or his lower-tier subcontractors or any other contractors as described herein.
2. In establishing schedule for Submittals, allow (10) days in Contractor's office for reviewing original Submittals and (5) days in Contractor's office for reviewing resubmittals.
3. Submittals requiring revision shall be resubmitted within (5) days after receipt of Contractor's review notations.
4. The schedule shall indicate the anticipated dates of original submission for each item and Contractor's approval thereof, and shall be based upon at least one resubmission of each item.
5. Schedule all Submittals required prior to fabrication or manufacture for submission within the time specified for each. Schedule Submittals pertaining to storage, installation, and operation at the Site for Contractor's approval prior to delivery of the Equipment and Materials.
6. Resubmit Submittals the number of times required for Contractor's "Submittal Approved." However, any need for resubmittals in excess of the number set forth in the accepted schedule, or any other delay in obtaining approval of Submittals, will not be grounds for extension of the Contract Times, provided Contractor completes its reviews within the times specified.

C. Transmittal of Submittals:
1. All Submittals (Shop Drawings, product data, and Samples) for Equipment and Materials furnished by Subcontractor, lower-tier subcontractors, manufacturers, and Suppliers shall be submitted to Contractor by Subcontractor.
2. After checking and verifying all field measurements, transmit all Submittals to Contractor for approval as follows:
    a. Mark each Submittal by Project name and number, Contract title and number, and the applicable Specification Section and Article number. Include in the letter of transmittal the Drawing number and title, sheet number (if applicable), revision number, and electronic filename (if applicable). Unidentifiable Submittals will be returned for proper identification.
    b. Check and approve Submittals of lower-tier subcontractors, Suppliers, and manufacturers prior to transmitting them to Contractor. Subcontractor's submission shall constitute a representation to Contractor that Subcontractor approves Submittals and has determined and verified all quantities, dimensions, field construction and installation criteria, materials, catalog numbers, compliance with Laws and Regulations, and similar data, and Subcontractor assumes full responsibility for doing so; and Subcontractor has coordinated each Submittal with the requirements of the Work and the Contract Documents.

c. At the time of each submission, call to the attention of Contractor in the letter of transmittal any deviations from the requirements of the Contract Documents.
d. Make all modifications noted or indicated by Contractor and return revised Submittals until approved. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by Contractor on previous Submittals. After Submittals have been approved, submit copies thereof for final distribution. Previously approved Submittals transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, correct the Submittal and resubmit for review.
e. Following completion of the Work and prior to final payment, furnish record documents and approved Samples and Shop Drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in Equipment instruction books and operating manuals as required. All such copies shall be clearly marked "PROJECT RECORD."
f. Keep a copy or sample of each Submittal in good order at the Site.

3. Quantity Requirements:
   a. Except as otherwise specified, transmit all Shop Drawings and submittals of product data in the following quantities:
      (1) Initial Submittal: Electronic – One copy to Contractor.
      (2) Resubmittals: Electronic – One copy to Contractor.
      (3) Submittal for final distribution: Electronic – One copy to Contractor.
      (4) As-constructed documents: Electronic – One copy to Contractor.
   b. Transmit Submittals of Material Samples, color charts, and similar items as follows:
      (1) Initial Submittal – One to Contractor.
      (2) Resubmittal – One to Contractor.
   c. Transmit Submittals of Equipment instruction books and operating manuals as follows:
      (1) Initial Submittal: Electronic – One copy to Contractor.
      (2) Resubmittals: Electronic – One copy to Contractor.
      (3) Submittal for Final Distribution: Electronic and two (2) bound copies to Contractor.
   d. When all Submittals have been updated to "as-constructed" conditions, transmit to Contractor in electronic format.
   e. Contractor may copy and use for Owner's internal operations and staff training purposes any and all document Submittals required by this Contract and approved for final distribution, whether or not such documents are copyrighted, at no additional cost to Contractor.
4. Equipment erection drawings and other Submittals required for the installation of Equipment furnished by others under separate contract for installation under this Contract will be transmitted to Subcontractor by Contractor in the final distribution of such Submittals.

D. Contractor's Review:
1. Contractor will review and take appropriate action on Submittals in accordance with the accepted schedule of Submittals. Contractor's review and approval will be only to determine if the items of Equipment and Materials covered by the Submittals will, after installation or incorporation in the Work, conform to information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Contractor's review and approval will not extend to design data reflected in Submittals which is peculiarly within the special expertise of Subcontractor or Subcontractor's lower tier subcontractors or Suppliers. Review and approval of a component item as such will not indicate approval of the assembly in which the item functions.

3. Contractor's review and approval of Shop Drawings, product data, or Samples will not relieve Subcontractor of responsibility for any deviation from requirements of the Contract Documents unless Subcontractor has in writing called Contractor's attention to such deviation at the time of submission, and Contractor has given written concurrence in and approval of the specific deviation. Approval by Contractor shall not relieve Subcontractor from responsibility for errors or omissions in Submittals.

E. Submittal Action Stamp:

1. Contractor's review action stamp, appropriately completed, will appear on all Submittals of Subcontractor when returned by Contractor. Review status designations listed on Contractor's action stamp are defined as follows:

A - SUBMITTAL APPROVED: Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work. Subcontractor is to proceed with fabrication or procurement of the items and with related Work. Copies of the Submittal are to be transmitted to Contractor for final distribution.

B - SUBMITTAL APPROVED AS NOTED (RESUBMIT): Signifies Equipment and Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work in accordance with Contractor's notations. Subcontractor is to proceed with fabrication or procurement of the items and with related Work in accordance with Contractor's notations and is to submit a revised Submittal responsive to notations marked on the returned Submittal or written in the letter of transmittal.

C - SUBMITTAL RETURNED FOR REVISION (RESUBMIT): Signifies Equipment and Material represented by the Submittal appears to conform with the design concept and comply with the intent of the Contract Documents but information is either insufficient in detail or contains discrepancies which prevent Contractor from completing its review. Subcontractor is to resubmit revised information responsive to Contractor's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related Work is not to proceed until the Submittal is approved.

D - SUBMITTAL NOT APPROVED (SUBMIT ANEW): Signifies Equipment and Material represented by the Submittal does not conform with the design concept or comply with the intent of the Contract Documents and is disapproved for use in the Work. Subcontractor is to provide Submittals responsive to the Contract Documents.

E - PRELIMINARY SUBMITTAL Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. Contractor is to submit such additional information to permit layout and related activities to proceed.

F - FOR REFERENCE, NO APPROVAL REQUIRED: Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to Contractor or Owner in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the

intent of the Contract Documents. Contractor reviews such Submittals for general content but not for basic details.

G - DISTRIBUTION COPY (PREVIOUSLY APPROVED) Signifies Submittals which have been previously approved and are being distributed to Contractor, Owner, Resident Project Representative, and others for coordination and construction purposes.

F. Instruction Books and Operating Manuals:
   1. Equipment instruction books and operating manuals prepared by the manufacturer shall include the following:
      a. Index and tabs.
      b. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers.
      c. Applicable drawings.
      d. Warranties and guarantees.
      e. All additional data specified.
      f. The following information shall be imprinted, inserted or affixed by label on the binder front cover and spine:
         (1) Owner's name.
         (2) Owner's facility.
         (3) Operation and Maintenance Manual for the Project Name.
         (4) System(s) included in O&M Manual
         (5) Volume number (if applicable).

1.04 INFORMATIONAL SUBMITTALS:

A. Informational Submittals are comprised of technical reports, administrative Submittals, and guarantees which relate to the Work, but do not require Contractor approval prior to proceeding with the Work. Informational Submittals include:
   1. Welder qualification tests.
   2. Welding procedure qualification tests.
   3. X-ray and radiographic reports.
   4. Hydrostatic testing of pipes.
   5. Field test reports.
   6. Concrete cylinder test reports.
   7. ASME pressure vessel test reports.
   8. Certification on Materials:
      a. Steel mill tests.
      b. Roofing laboratory tests.
      c. Brick and concrete masonry unit laboratory tests.
      d. Paint laboratory tests.
      e. Metal paneling laboratory tests.
      f. Cement tests.
   9. Soil test reports.
   10. Air handling balancing reports.
   11. Temperature records.
   12. Piping stress analysis.
   13. Shipping or packing lists.
   14. Job progress schedules.
   15. Equipment and Material delivery schedules.

16. Progress photographs.
17. Warranties and guarantees.
18. Fire protection and hydraulic calculations.

B. Transmittal of Informational Submittals:
   1. All informational Submittals furnished by lower-tier subcontractors, manufacturers, and Suppliers shall be submitted to Contractor by Subcontractor unless otherwise specified.
      a. Identify each informational Submittal by Project name and number, Contract title and number, and the Specification Section and Article number marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
      b. At the time of each submission, call to the attention of Contractor in the letter of transmittal any deviations from the requirements of the Contract Documents.
   2. Quantity Requirements:
      a. Technical reports and administrative Submittals except as otherwise specified:
         (1) Electronic: One copy to Contractor.
      b. Written Certificates and Guarantees:
         (1) Contractor: two copies.

C. Contractor's Review:
   1. Contractor will review informational Submittals for indications of Work or Material deficiencies.
   2. Contractor will respond to Subcontractor on those informational Submittals which indicate Work or Material deficiency.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION - NOT APPLICABLE

END OF SECTION 01 33 05

SECTION 01 57 13 - TEMPORARY EROSION, SEDIMENT, AND POLLUTION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes temporary measures and monitoring to control water pollution, soil erosion, and siltation. Erosion, sediment, and pollutant control (ESPC) devices or methods include the use of berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, sediment (filter) fences, grasses, slope drains, and other techniques.

1.2 DESCRIPTION OF SOILS

A. From *Report of Geotechnical Engineering Services*, Haley Aldrich, dated November 2023, geotechnical explorations encountered up to 7 to 16 feet of dredge sand fill overlying overbank deposits of Columbia River Sand Alluvium up to 50 feet bgs, which then overlies sand of the Columbia River Sand Aquifer to the base of the explorations.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02 41 19 – Selective Demolition

B. Section 31 20 01 – Site Preparation and Earthwork – Fuel Systems

C. Section 32 92 00 – Clearing and Seeding

1.4 REFERENCES AND APPLICABLE CODES

A. ASTM: American Society for Testing Materials
   1. ASTM D4355: Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
   2. ASTM D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity
   3. ASTM D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles
   4. ASTM D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
   5. ASTM D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile
   6. ASTM D6241: Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

B. National Pollutant Discharge Elimination System (NPDES) General Permit 1200-CA dated February 20, 2001.

C. City of Portland, Erosion Control Manual.

D. City of Portland Title 10, Chapter 10.10 – 10.80.

E. Oregon DEQ: Oregon Department of Environmental Quality

1.5 PERMITS

A. The Port is the administrator of the NPDES General Permit 1200-CA for the Discharge of Construction Site Runoff to Public Waters on projects performed by or for the Port on Port property. A copy of the permit and its regulations is on file at the Port's Engineering offices. The Port is mandated by law to comply with this permit. The Contractor and all Subcontractors shall comply with the requirements of the permit.

1.6 SUBMITTALS

A. At the pre-construction meeting, submit the following supplemental ESPC information:
   1. Construction start and completion dates.
   2. Dates when ESPC measures will be in place.
   3. Projected date of removal of erosion control structures (after soil is stabilized by vegetation or pavement).
   4. Description of control procedures to prevent the discharge of all wash water from concrete trucks into the storm sewer system.
   5. Description of procedures for prompt maintenance or repair of ESPC measures utilized on-site.
   6. Description of clearing and grading practices, including a schedule of implementation, that will minimize the area of exposed soil throughout the duration of the project. (Whenever practicable, clearing and grading shall be phased to prevent exposed inactive areas from becoming a source of erosion.)
   7. Description of best management practices that will be used to prevent or minimize storm water from being exposed to pollutants from spills, cleaning and maintenance activities, and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery as well as debris, leftover paints, solvents, and glues from construction operations.
   8. Name, title, and telephone number of designated employee to perform the Subcontractor's inspection and monitoring of ESPC measures.

B. Any requested changes or modifications to the ESPC measures shown on the drawings shall be submitted to the Contractor, who will submit them to the Port for approval, prior to implementation. Upon request by the Port, the Contractor shall submit updated ESPC drawings which include the latest modifications.

C. ESPC inspection records shall be submitted to the Contractor monthly, to be submitted to the Port.

PART 2 - PRODUCTS

2.1 SEDIMENT FENCE

A. Meet the requirements of ASTM D6461.

2.2 INLET AND TRENCH DRAIN PROTECTION

A. Geotextile filter fabric (nonwoven) for inlet and trench drain protection shall meet the following material specification requirements.

PROPERTY	TEST METHOD	ENGLISH
Grab Tensile Strength (minimum) Machine and Cross Machine Directions	ASTM D4632	200 lbs
Tear Strength (minimum)	ASTM D4533	80 lbs
Puncture Strength (minimum)	ASTM D6241	430 lbs
Apparent Opening Size (AOS) (maximum) U.S. Standard Sieve	ASTM D4751	40 US Sieve
Permittivity (minimum)	ASTM D4491	0.50 Sec-1
Ultraviolet Stability Retained Strength (minimum) @ 500 Hours	ASTM D4355	70%

2.3 WATTLES

A. General: Wattles shall be made of straw and shall meet the requirements below. Wrap the straw to a minimum density of 2.75 pounds per cubic foot in tubular netting.

B. Plastic Netting:
   1. 8-inch to 10-inch diameter size.
   2. Minimum strand thickness of 0.003 inch.
   3. Knot thickness of 1/16 inch.
   4. Weight of 0.35 ounces per foot ±10 percent.
   5. Made from 85 percent high density polyethylene, 14 percent ethyl vinyl acetate, and 1 percent color for UV inhibition.

C. Straw:
   1. Use straw mulch prepared for non-hydroseeding applications from bentgrass, bluegrass, fescue or ryegrass singly or in combination. Cereal grain straw from barley, oat, or wheat may be allowed upon approval of the Port.

2. Provide straw that is not moldy, caked, decayed, or of otherwise low quality.
3. Submit certification from the supplier that the straw is free of noxious weed seeds or plant parts. Acceptable documentation is any one of the following:
   a. The straw source is an "Oregon Certified Seed" field.
   b. The straw is certified by a recognized program accepted by the Oregon Department of Agriculture as being weed free.
   c. Seed lab test results of seed harvested from the straw meet minimum Oregon Certified Seed quality for weed seed content.

PART 3 - EXECUTION

3.1 GENERAL

A. The implementation of the ESPC measures and the construction, performance monitoring, maintenance, replacement, and upgrading of the ESPC measures are the responsibility of the Subcontractor until all construction is completed and accepted and vegetation/landscaping is established.

B. The ESPC measures shown on the drawings shall be constructed in conjunction with all clearing, grading, trenching, and earthwork activities and in a manner that ensures that sediment and sediment-laden water do not enter the drainage system, roadways, or violate applicable water quality standards.

C. The ESPC measures shown on the drawings are the minimum requirements for anticipated site conditions and Subcontractor methods and sequences. During the construction period, the ESPC measures shall be upgraded as needed for unexpected conditions, storm events, or Subcontractor methods or sequences and to ensure that sediment and sediment-laden water do not leave the site.

D. The Subcontractor shall be responsible for implementing temporary erosion control measures during construction to correct unforeseen conditions. The Subcontractor shall be responsible for additional erosion control due to the Subcontractor's negligence, carelessness, or failure to install planned controls as a part of the work.

E. Implementation, construction, and maintenance of ESPC measures shall be in accordance with the City of Portland Erosion Control Manual.

3.2 CONSTRUCTION DETAILS

A. Install and maintain all site public notification signs where shown on the drawings and keep signs easily readable from the public right-of-way throughout the duration of the ground-disturbing activities. Remove and dispose of signs upon completion of work.

B. No visible or measurable erosion material or pollutant shall exit the construction site. Visible or measurable is defined as:
   1. Deposits of mud, dirt, sediment or similar material exceeding 1/2 cubic foot in volume in any area of 100 square feet or less on public or private streets, adjacent property, or into

the storm and surface water system, either by direct deposit, dripping, discharge, or as a result of the action of erosion.

2. Evidence of concentrated flows of water over bare soils; turbid or sediment laden flows; or evidence of on-site erosion such as rivulets on bare soil slopes, where the flow of water is not filtered or captured on the site.
3. Earth slides, mud flows, earth sloughing, or other earth movement which leaves the property.

C. Employ all reasonable means and methods to control or divert upslope stormwater runoff away from cleared and grubbed areas, stockpiled materials, and other disturbed areas that will be open or stockpiled for periods longer than 2 weeks.

D. Construction entrances, exits, and parking areas shall be graveled or paved to reduce the tracking of sediment onto public or private roads. Maintain for the duration of the project.

E. Unpaved roads on the site shall be graveled or under other effective erosion and sediment control measures, either on the road or down gradient, to prevent sediment and sediment-laden water from leaving the site.

F. Preserve existing vegetation where practicable and revegetate open areas after grading or construction.

G. Continuously secure or protect soil stockpiles from runoff and erosion throughout the project with temporary soil stabilization measures or protective cover.

H. If construction activities cease for 30 days or more, the entire site shall be stabilized using vegetation or a heavy mulch layer, temporary seeding, or another method that does not require germination to control erosion.

I. If construction activities cease for 15 days or more on any significant portion of the work site, that portion of the site shall be stabilized using straw, compost, or other tackified covering that prevents soil and wind erosion.

J. Any use of toxic or other hazardous materials shall include proper storage, application, and disposal.

K. When trucking saturated soils from the site, either watertight trucks shall be used or loads shall be drained on-site until dripping has been reduced to minimize spillage on roads and streets.

L. Clean all catch basins and inlets protected from sediment prior to paving and final acceptance. The cleaning operation shall not flush sediment laden water into the downstream system.

M. ESPC measures installed during construction shall be removed when construction and site disturbance activity are complete and permanent soil stabilization is in place.

N. Remove and dispose of waste and unused building material.

3.3 MONITORING AND REPORTING REQUIREMENTS

A. The Subcontractor shall designate an employee to perform inspections of ESPC measures. Inspections shall be conducted by a person knowledgeable in the principles and practice of erosion and sediment controls who possesses the skills to assess conditions at the construction site that could impact stormwater quality, is knowledgeable in the correct installation of the erosion and sediment controls, and is able to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activity.
   1. For projects of five or more acres, inspections shall be conducted by a person certified in an erosion and sediment control program approved by Oregon DEQ including, but not limited to:
      a. Certified Professional in Erosion and Sediment Control.
      b. Certified Professional in Stormwater Quality.
      c. Washington State Certified Erosion and Sediment Control Lead.
      d. Rogue Valley Sewer Services Erosion and Sediment Control Certification.

B. Inspect erosion control measures daily and maintain as necessary to ensure their continued functioning.

C. For inactive periods of work, inspect ESPC measures at least once every 14 days and within 24 hours after any storm with precipitation greater than 0.5 inches per 24-hour period.

D. Visibly monitor stormwater runoff to evaluate the effectiveness of the erosion control measures or practices. If visible quantities of sediment are leaving the property, take corrective action immediately. Notify the Port of all corrections and violations.

E. The Subcontractor shall keep a record of inspections. This record shall be made available to the Port upon request and shall be submitted monthly.

F. Visual inspections shall document the following information:
   1. Inspection date, inspector's name, weather conditions, and rainfall amount for past 24 hours (inches). (Rainfall information can be obtained from the nearest weather recording station.)
   2. List observations of all best management practices (BMPs): Erosion and sediment controls, chemical and waste controls, locations where vehicles enter and exit the site, status of areas that employ temporary or final stabilization control, soil stockpile area, and non-stormwater controls.
   3. At representative discharge location(s) from the construction site, conduct observation and document the quality of the discharge for any turbidity, color, sheen, or floating materials. If possible, in the receiving stream, observe and record color and turbidity or clarity upstream and downstream within 30 feet of the discharge from the site. For example, a sheen or floating material shall be noted as present/absent. If present, it may indicate possible spill and/or leakage from vehicles or materials storage. Observation for turbidity and color shall describe any apparent color, the clarity of the discharge, and apparent differences compared with the receiving stream.
   4. If visual or measurable amounts of sediment are leaving the property, briefly explain the corrective measures taken to reduce the discharge and/or clean it up. Describe efforts to prevent future releases. The ESPC shall be amended accordingly.

5. If a site is inaccessible due to inclement weather, the inspection shall include observations at a relevant discharge point or downstream location, if practical.

END OF SECTION 01 57 13

SECTION 01 78 05 – CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY:

A. Definition:

1. "Closeout": is defined to include general requirements near the end of Contract Time, in preparation for installation by others, performance and acceptance testing, final acceptance, final payment, normal termination of Contract, and similar actions evidencing completion of the Work. Time of closeout is directly related to "Substantial Completion" of the contract, and therefore may be either a single time period for the entire Work or a series of time periods for individual units of the Work which have been certified as Substantially Complete at different dates.
2. "Substantial Completion": means the event when (i) installation of the Equipment and Materials furnished by this Contract has been completed by the installing Subcontractor and required Field Services have been furnished, (ii) the Equipment and Materials are operating safely for the purpose of commissioning and startup, (iii) all testing of the Work has been completed and all test data properly evaluated, (iv) the performance guarantees have been met and warranty period started, and (v) Subcontractor has delivered to Contractor all operating instructions, maintenance manuals, and warranties.

1.02 RELATED REQUIREMENTS:

A. Prerequisites for Final Acceptance and Payment: SUBCONTRACT AGREEMENT.
B. Submittals: Section 01 33 05.

1.03 REQUIREMENTS FOR FINAL PAYMENT:

A. General: Unless otherwise required elsewhere by these Contract Documents, the following shall be furnished to Contractor prior to application for final payment.
1. Field Services.
2. Maintenance and operating instructions.
3. Guarantees.
4. Certifications of inspection.
5. "Record Document" Submittals.
6. Other documents as required by Contract Documents.
7. Spare parts.

B. Final Payment: Specified in SUBCONTRACT AGREEMENT .

1.04 PROJECT RECORD DOCUMENTS:

A. Recording:
1. Label each document "PROJECT RECORD" in neat, large, printed letters.
2. Record Drawings: Legibly mark to record actual construction:
a. Where Submittals are used for mark-up, record a cross-reference at corresponding location on Drawings.
b. Field changes of dimension and detail.
c. Changes made by Change Order or other Modifications.
d. Details not on original Contract Drawings.
3. Instruction Books and Operating Manuals: Specified in Section 01 33 05.

1.05 WARRANTIES AND BONDS:

A. Specified in Section 01 33 05 and elsewhere in the Contract Documents.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION - NOT APPLICABLE

END OF SECTION 01 78 05

SECTION 02 41 19 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.03 RELATED REQUIREMENTS:

A. Section 31 20 01 – Site Preparation and Earthwork – Fuel Systems.

1.04 REFERENCE STANDARDS:

A. The American Society of Safety Engineers
   1. ASSE A10.6-2006: Safety Requirements for Demolition Operations (ANSI)
B. Code of Federal Regulations
   1. 40 CFR 82-2012: Protection of Stratospheric Ozone
C. NFPA
   1. NFPA 241-2013: Safeguarding Construction, Alteration, and Demolition Operations

1.05 DEFINITIONS:

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Contractor ready for reuse.
C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.06 MATERIALS OWNERSHIP:

A. Unless otherwise indicated, demolition waste becomes property of Contractor.
B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.07 PREINSTALLATION MEETINGS:

A. Pre-demolition Conference: Conduct conference at Portland International Airport, Portland, OR
   1. Inspect and discuss condition of construction to be selectively demolished.

2. Review structural load limitations of existing structures.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.08 SUBMITTALS:

A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.
B. Schedule of Selective Demolition Activities: Indicate the following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Coordination for shutoff, capping, and continuation of utility services.
   4. Coordination of Owner's continuing occupancy of portions of existing facility and of Owner's partial occupancy of completed Work.
C. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Submit before Work begins.
D. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition (if applicable).
E. Inventory: Submit a list of items that have been removed and salvaged.

1.09 QUALITY ASSURANCE:

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.10 FIELD CONDITIONS:

A. Owner will occupy portions of facility immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
B. Subcontractor shall notify Contractor of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
D. If suspected hazardous materials are encountered, do not disturb; immediately notify Contractor. Hazardous materials will be removed by Contractor under a separate contract.
E. Storage or sale of removed items or materials on-site is not permitted.
F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
   1. Maintain fire-protection facilities in service during selective demolition operations.

1.11 WARRANTY:

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. The Subcontractor is responsible for verifying with the Contractor any existing warranties that may be affected.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.12 COORDINATION:

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Contractor. Contractor does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Engage a professional Engineer to perform an engineering survey of condition of existing structures to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings and preconstruction photographs or video.

1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off utilities with utility companies and notify Contractor at least 48 hours prior to shut off.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3. Disconnect, demolish, and remove utility systems, equipment, and components indicated on Drawings to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Contractor.

3.03 PROTECTION:

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
    1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
    2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
    3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
    4. Cover and protect equipment that have not been removed.
B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
    1. Strengthen or add new supports when required during progress of selective demolition.
C. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION, GENERAL:

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
    1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
    2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
    3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
    4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
    5. Maintain fire watch during and for at least 1/2 hour after flame-cutting operations.

6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Contractor.
4. Transport items to Contractor's storage area designated by Contractor.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Contractor, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.05 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS:

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

3.06 DISPOSAL OF DEMOLISHED MATERIALS:

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

3.07 CLEANING:

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 02 61 00 - REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes excavation and disposal of soil contaminated with petroleum and other products.

B. If the Subcontractor encounters suspected contaminated soil in the work area beyond that mentioned in the contract documents, the Subcontractor shall immediately stop all work in the area of the suspected contamination and notify the Port of Portland (Port). The Port will characterize contaminated soil, obtain profile for disposal, and determine the location of disposal.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 20 01 – Site Preparation and Earthwork - Fuel Systems

1.3 SUBMITTALS

A. Submit copies of all receipts for processing contaminated soil at the disposal facility.

1.4 DISPOSAL DOCUMENTATION

A. The Port will prepare all documentation required for characterization and disposal of contaminated soil at the disposal facility.

1.5 DEFINITIONS

A. Contaminated Soil: Soil that produces a fuel or chemical odor, produces an oil sheen on the surface of water, has staining, contains debris or other visible indicators, or soil designated by the Port as contaminated.

PART 2 - PRODUCTS

2.1 PLASTIC SHEETING

A. Minimum 6 mil polyethylene sheeting.

PART 3 - EXECUTION

3.1 GENERAL

A. The Port will provide field and laboratory evaluation of materials suspected of being contaminated.

B. Notify the Port 48 hours before excavating in an area of known or suspected contamination.

C. The Port will designate which materials are contaminated and which are suitable for use in the work.

D. The Port will determine the disposition of all materials.

E. The Subcontractor shall assist the Port in collecting soil samples from excavator buckets or by briefly stopping work to allow observations or samples to be collected.

3.2 EXCAVATION AND STOCKPILING

A. All contaminated excavated material is the property of the Port and will be handled per direction by the Port.

B. Excavation to remove material determined by the Port to be contaminated shall be performed as described in Section 31 20 01 – Site Preparation and Earthwork - Fuel Systems and shall be made to the depth and extent as determined by the Port. Where necessary, backfill excavations with appropriate material as directed by the Port.

C. Provide adequate containment of and protection from contaminated material, suited to the type of contamination. Follow all federal, state, and local requirements in excavating, loading, transporting, and otherwise handling or working around contaminated material. The Subcontractor shall be responsible for meeting all regulatory requirements.

D. Place contaminated soil in a stockpile separate from clean materials.

E. Stockpile contaminated soil on pavement or on plastic sheeting. The perimeter of the plastic sheeting shall be elevated to prevent overland stormwater flow from contacting the contaminated soil. Pavement may substitute for the plastic sheeting if there is a method for preventing stormwater flow into the stockpile (i.e., a curb on the uphill side of the stockpile).

F. Cover contaminated soil stockpile with plastic sheeting when the stockpile is not actively involved in construction. Secure the plastic covering to ensure it stays in place and that stormwater runoff from the cover does not pond on the cover or contact the contaminated soil.

G. As directed by the Port, contaminated stockpiles shall remain in place for a minimum of 48 hours to allow for complete chemical analysis.

3.3 DISPOSAL

A. The Port will characterize contaminated soil and obtain the profile for disposal.

B. Contaminated soil will be disposed of by a third party, hired by the Port. The Subcontractor shall provide full access to the contaminated material stockpile. This may include third party excavation, handling, and transportation equipment.

END OF SECTION 02 61 00

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Foundations.
   2. Structural slabs and pile caps.
   3. Concrete pads and slabs-on-grade.

1.03 REFERENCES:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American Association of State Highway and Transportation Officials:
   1. AASHTO M 182-05(21) - Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

C. American Concrete Institute:
   1. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
   2. ACI 301 - Specifications for Structural Concrete.
   3. ACI 302.1R - Guide to Concrete Floor and Slab Construction.
   4. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   5. ACI 304.2R - Placing Concrete by Pumping Methods.
   6. ACI 305R – Guide to Hot Weather Concreting.
   7. ACI 306R – Guide to Cold Weather Concreting.
   8. ACI 308.1 - Specification for Curing Concrete.
   9. ACI 309 – Guide for Consolidation of Concrete.
   10. ACI 318-19 - Building Code Requirements for Structural Concrete.
   11. ACI 347R - Guide to Formwork for Concrete.
   12. ACI CP-1 - Technical Workbook for ACI Certification of Concrete Field Testing Technician - Grade I.
   13. ACI SP-66-04 - ACI Detailing Manual.

D. American Institute of Steel Construction:
   1. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.

E. ASTM International:
   1. ASTM A615/A615M - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   3. ASTM A884/A884M - Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
   4. ASTM A1064/A1064M - Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   5. ASTM A1078/1078M - Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement

6. ASTM C31/C31M - Practice for Making and Curing Concrete Test Specimens in the Field.
7. ASTM C33 - Specification for Concrete Aggregates.
8. ASTM C39/C39M - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
9. ASTM C42/C42M - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
10. ASTM C94/C94M - Specification for Ready-Mixed Concrete.
11. ASTM C109/C109M - Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
12. ASTM C114 - Test Methods for Chemical Analysis of Hydraulic Cement.
13. ASTM C143/C143M - Test Method for Slump of Hydraulic-Cement Concrete.
14. ASTM C150 - Specification for Portland Cement.
15. ASTM C171 - Specification for Sheet Materials for Curing Concrete.
16. ASTM C172 - Practice for Sampling Freshly Mixed Concrete.
17. ASTM C219 - Terminology Relating to Hydraulic Cement.
18. ASTM C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260a - Specification for Air-Entraining Admixtures for Concrete.
20. ASTM C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
21. ASTM C430 - Test Method for Fineness of Hydraulic Cement by the 45-µm (No. 325) Sieve.
22. ASTM C494/C494M - Specification for Chemical Admixtures for Concrete.
23. ASTM C595 - Specification for Blended Hydraulic Cements.
24. ASTM C618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
25. ASTM C881/C881M - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
26. ASTM C920 - Specification for Elastomeric Joint Sealants.
27. ASTM C989 - Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
28. ASTM C1017/C1017M - Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
29. ASTM C1059/C1059M - Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
30. ASTM C1064/C1064M - Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
31. ASTM C1077 - Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
32. ASTM C 1107 - Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
33. ASTM C1218 / C1218M - Water-Soluble Chloride in Mortar and Concrete.
34. ASTM C1240 - Specification for Silica Fume Used in Cementitious Mixtures.
35. ASTM C1293 (Reapproved 2015) - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
36. ASTM C1567 - Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate.

37. ASTM C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
38. ASTM D1751 - Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
39. ASTM D1752 - Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
40. ASTM E329 - Specification for Agencies Engaged in Construction Inspection and/or Testing.

F. Concrete Reinforcing Steel Institute:
1. Manual of Standard Practice. 29th ed. 2017.

G. Federal Specifications (FS)
1. SS-S-0200E - Joint Sealants, Two-Component, Jet-Blast Resistant, Cold-Applied, for Portland Cement Concrete Pavement
2. TT-S-00227E - Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing and Glazing in Buildings and Other Structures)
3. TT-S-00230C - Sealing Compound: Elastomeric Type, Single Component (for Caulking, Sealing and Glazing in Buildings and Other Structures)

H. National Ready Mixed Concrete Association:
1. Certification of Ready Mixed Concrete Production Facilities.

1.04 DEFINITIONS:

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
B. W/CM Ratio: The ratio by weight of water to cementitious materials.

1.05 SUBMITTALS:
A. Submit as specified in Division 01.
B. Product Data: For each type of product to be used on the Project.
C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
1. Indicate specific use/area for each proposed mix design.
2. Indicate amounts of mixing water to be withheld for later addition at Project site.
3. Include lab test results for 7-day and 28-day compressive strength tests.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Indicate size and location of all openings.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 117
2. ACI 301, Sections 1 through 5.

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Preinstallation Conference: Conduct conference at PDX Fuel Facility.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete subcontractor.
   e. Special concrete finish subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS:

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls in containment structures and those indicated to receive dampproofing or waterproofing.

2.02 STEEL REINFORCEMENT:

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Plain-Steel Wire: ASTM A1064/A1064M, galvanized.

C. Deformed-Steel Wire: ASTM A1064/A1064M.

D. Epoxy-Coated Wire: ASTM A884/A884M, Class A, Type 1 coated, as-drawn, plain-steel wire, with less than 2% damaged coating in each 12-inch wire length.

E. Galvanized-Steel Welded Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.

2.03 REINFORCEMENT ACCESSORIES:

A. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, epoxy-coated in the fabrication shop in accordance with ASTM A1078/A1078M. Cut true to length with ends square and free of burrs.

B. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement complying with ASTM A775/A775M and on dowels complying with ASTM A1078/A1078M.

C. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to ACI SP-66 and CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. Precast concrete bar supports shall be of greater compressive strength than surrounding concrete and have a minimum bearing area of 9 sq. inches. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage.
2. For concrete slabs on vapor retarder, use only precast concrete bar supports or provide 6-inch square protective pads of asphaltic hardboard or other material recommended by the vapor retarder manufacturer.
3. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.
4. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
5. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

2.04 CONCRETE MATERIALS:

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150, Type I/II or Type 1L. Supplement with the following:
   a. Fly Ash: ASTM C618, Class F or C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
2. Blended Hydraulic Cement: ASTM C595, Type IS, Portland blast-furnace slag, Type IP, Type II, Portland-pozzolan Type I (PM), pozzolan-modified Portland or Type I (SM), slag-modified Portland cement.
3. The maximum amount retained on the No. 325 sieve shall be 10% as determined according to ASTM C430.
4. The maximum amount of alkalies ($NA_2O + 0.658\ K_2O$) shall be 0.60% determined according to ASTM C114. A running average of three samples shall not exceed a maximum of 0.50%.

B. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C33, Class 4S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2-inch for footings, 3/4-inch nominal for all slabs and containment walls, and 1-inch nominal for others, unless indicated otherwise.
2. Fine Aggregate:
   a. Free of materials with deleterious reactivity to alkali in cement.
3. Fineness modulus shall be between 2.3 and 3.1. Alkali-Aggregate Reaction: Do not use any aggregate susceptible to alkali-carbonate reaction (ACR). Use one of the three

options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction (ASR):

a. For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 must not exceed 0.04 percent at one year.
b. For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 must not exceed 0.10 percent at an age of 16 days.
c. Alkali content in concrete (LBA) must not exceed 4 pounds per cubic yard for moderately reactive aggregate or 3 pounds per cubic yard for highly reactive aggregate. Reactivity must be determined by testing in accordance with ASTM C1293 and categorized in accordance with ASTM C1778. Alkali content is calculated as follows: LBA = (cement content, pounds per cubic yard) × (equivalent alkali content of portland cement in percent/100 percent).

D. Water: ASTM C94/C94M and potable.

2.05 ADMIXTURES:

A. Air-Entraining Admixture: ASTM C260.
B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
C. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
   1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
      a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
      b. Cortec Corporation; MCI- 2005NS.
      c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
      d. Sika Corporation; FerroGard 901
D. Color Pigment: ASTM C979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
   1. Color: Red for electrical ductbanks or as indicated.

2.06 WATERSTOPS:

A. Fuel Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to Jet –A fuel. Factory fabricate corners, intersections, and directional changes.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. JP Specialties, Inc.; Earth Shield TPV.
      b. Sika Corporation; WESTEC TPER.

c. Vinylex Waterstop & Accessories; PetroStop .

2. Profile: Ribbed with center bulb.
3. Dimensions: Unless indicated otherwise, 6 inches by 3/16 inch thick; non-tapered.

2.07 LIQUID FLOOR TREATMENTS:

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Sealer-Hardener: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, densifies and seals concrete surfaces.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. ChemMasters; Chemisil Plus.
   b. ChemTec Int'l; ChemTec One.
   c. Conspec by Dayton Superior; Intraseal.
   d. Curecrete Distribution Inc.; Ashford Formula.
   e. Dayton Superior Corporation; Sure Hard (J-17).
   f. Euclid Chemical Company (The); Euco Diamond Hard.
   g. Kaufman Products, Inc.; SureHard.
   h. L&M Construction Chemicals, Inc.; Seal Hard.
   i. Laticrete; L&M Seal Hard.Metalcrete Industries; Floorsaver.
   j. Nox-Crete Products Group; Duro-Nox.
   k. Symons by Dayton Superior; Buff Hard.
   l. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.
   m. W.R. Meadows, Inc.; LIQUI-HARD.

2.08 CURING MATERIALS:

A. Evaporation Retardant: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Use to reduce rapid moisture loss from the concrete surfaces after placement and prior to curing.
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. BASF Corporation-Construction Systems; Confilm.
   b. ChemMasters, Inc.; SprayFilm.
   c. Dayton Superior; AquaFilm Concentrate J74.
   d. Euclid Chemical Company (The), an RPM company; Eucobar.
   e. Kaufman Products, Inc.; Vapor-Aid.
   f. L&M Construction Chemicals, Inc.; E-CON.
   g. Lambert Corporation; LAMBCO Skin.
   h. Metalcrete Industries; Waterhold.
   i. Nox-Crete Products Group; MONOFILM.
   j. Sika Corporation; SikaFilm.
   k. SpecChem, LLC; Spec Film.
   l. TK Products; TK-2120 TRI-FILM.
   m. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
   n. W. R. Meadows, Inc.; EVAPRE.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry. Cover with polyethylene film (4 mil minimum thickness) after placement.
C. Moisture-Retaining Cover: ASTM C171, white burlap-polyethylene sheet.
D. Water: Potable.

E. White-pigmented, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipating.
1. Unless indicated otherwise, use for curing of all exterior concrete surfaces.
2. Do not use this method for curing concrete in areas to receive penetrating liquid sealer-hardener or epoxy coating.
3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dayton Superior; White Resin Cure J10W.
b. Euclid Chemical Company (The; Kurez VOX White Pigmented.
c. Kaufman Products, Inc.; Thinfilm 450.
d. Laticrete; L&M Cure W2
e. SpecChem, LLC; Pavecure Rez White.
f. Symons by Dayton Superior; Resi-Chem White.
g. W. R. Meadows, Inc.; 1200-WHITE.

2.09 RELATED MATERIALS:
A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, ASTM D1752, or 100% recycled material meeting ASTM D1752 (subparagraphs 5.1 to 5.4). Material shall be 1/2" thick, unless otherwise indicated. Provide asphalt-impregnated fiber material for exterior joints without joint sealant or joints in areas not subjected to fuel exposure. Use only ASTM D 1752 Type II cork material in the areas with possible exposure to fuel.
B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
D. Bond Breaker: Polyethylene tape or other plastic tape as recommended by sealant manufacturer.
E. Sealant Backer Rod: Provide closed cell backer rod as recommended by sealant manufacturer.
F. Joint Sealants Fuel-resistant:
1. Horizontal Surfaces: Use one- or two-component, fuel resistant, self-leveling, modified urethane or polyurethane conforming to FS TT-S-00227E, FS TT-S-00230C or FS SS-S-200E and ASTM C-920 Type S or M Grade P. Use gray colored sealant unless indicated or approved otherwise. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. BASF – MasterSeal CR 125.
b. Pecora Corporation – Urexpan NR-300.
c. Sika – Sikaflex-2c SL
d. Tremco – Vulkem 202.
e. W. R. Meadows - Pourthane SL.

2. Vertical and sloping surfaces: Use one- or two-component, fuel resistant, non-sag, modified urethane or polyurethane conforming to FS TT-S-00227E, FS TT-S-00230C or FS SS-S-200 and ASTM C-920 Type S or M Grade NS. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Sika Corporation – Sikaflex 2c NS.
   b. Euclid Chemical Company – Eucolastic 2NS.
   c. Tremco - Dymonic 100
3. Prime joints with manufacturer's recommended primer.
4. Other sealants may be considered upon review of the product data and chemical resistancy information.

G. Non-shrink Grout: Cementitious, non-metallic, ASTM C1107.

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
   1. Cement Binder: ASTM C150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
   2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
   4. Compressive Strength: Not less than 5,000 psi at 28 days when tested according to ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5,000 psi at 28 days when tested according to ASTM C109/C109M.

2.11 CONCRETE MIXTURES, GENERAL:

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by at least 40%. Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
   1. Fly Ash: 25%.
   2. Combined Fly Ash and Pozzolan: 25%.

3. Ground Granulated Blast-Furnace Slag: 50%.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50% Portland cement minimum, with fly ash or pozzolan not exceeding 25%.
5. Silica Fume: 10%.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35% with fly ash or pozzolans not exceeding 25% and silica fume not exceeding 10%.
7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50% with fly ash or pozzolans not exceeding 25% and silica fume not exceeding 10%.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.10% by weight of cement tested in accordance with ASTM C1218.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions for electrical ductbanks as indicated.

2.12 CONCRETE MIXTURES FOR STRUCTURAL ELEMENTS:

A. All reinforced concrete pile caps, structural slabs and associated tie beams: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 6,000 psi at 28 days.
2. Maximum W/CM Ratio: 0.40.
3. Minimum Cementitious Materials Content: 520 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch (prior to admixture).
5. Air Content: 6% plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size.

B. All drive slabs, slab on grade, curbs, sidewalks, and shallow foundations:
1. Minimum Compressive Strength: 4,500 psi at 28 days.
2. Maximum W/CM Ratio: 0.45, except 0.40 for secondary containment walls, slabs and structures.
3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 6 % plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size. 5.5% plus or minus 1.5% at point of delivery for 1 1/2-inch nominal maximum aggregate size.

C. Concrete for Ductbanks and Guard Posts and Fence Posts: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 3,000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 5 inches, plus or minus 1 inch (prior to admixture)

4. Air Content: 6% plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size.
5. Add color pigment to Ductbanks as indicated in 2.11E.

D. Controlled Low Strength Material: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 3.5.
3. Slump Limit: 7 inches, plus or minus 1 inch.
4. Air Content: 5% plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size.

2.13 FABRICATING REINFORCEMENT:
A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING:
A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and furnish batch ticket information.
1. When air temperature is between 85 and 90ºF (30 and 32ºC), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90ºF (32ºC), reduce mixing and delivery time to 60 minutes.
B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.01 FORMWORK:
A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.
D. Construct forms tight enough to prevent loss of concrete mortar.
E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, reglets, recesses, and the like, for easy removal.

2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges (3/4 inch) of permanently exposed concrete, unless noted otherwise.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

M. Earth Forming: Concrete for footings, grade beams, or foundation walls not exposed to public view may be placed directly against soil, provided that earth or rock has been carefully trimmed, is uniform and stable, and meets compaction requirements specified in DIVISION 31, Section “Site Preparation and Earthwork.” Increase width of elements by a minimum of 4 inches from that indicated on Drawings to provide additional concrete cover for reinforcement.

3.02 EMBEDDED ITEMS:

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in SECTION 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.
4. Secure floor drains in place to prevent movement or flotation while placing concrete. Uniformly and accurately slope slab toward drains.

3.03 REMOVING AND REUSING FORMS:

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50ºF for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70% of its 28-day design compressive strength, but not less than 72 hours of cumulative curing at not less than 50ºF.

2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 STEEL REINFORCEMENT:

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Welding of reinforcing bars is not allowed.
2. For slabs on grade and for footing reinforcement, support bars or welded wire reinforcement directly over subgrade or capillary water barrier on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing. Precast concrete units must be not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have cast-in galvanized tie wire hooked for anchorage.
3. For bars or welded wire fabric not supported directly on soil or crushed rock, supports must be of plastic-coated steel or stainless steel protected bar supports. Do not use precast concrete blocks as spacers or to support bars or welded wire fabrics in elevated horizontal structures (i.e. slabs, beams, etc) or vertical structures (i.e. columns, walls, etc).

D. Do not bend bars embedded in hardened or partially hardened concrete without approval from Engineer. If bending is permitted, conform to procedures of ACI 301 unless otherwise prescribed by Engineer or the governing building code.

E. Splice steel where indicated or approved. Splices shall be in full contact and shall conform to ACI 318.

1. Unless otherwise indicated, lap splices shall be Class B as defined by ACI 318.
2. Any additional Contractor-proposed splice shall be submitted for acceptance of location and splice length. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Use wire ties that are 16-gage or larger, set with ends directed into concrete, not toward exposed concrete surfaces.

G. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Do not place reinforcement directly on subgrade, vapor barrier, or steel form deck and then pull up during concrete placement. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

H. Epoxy-Coated Dowels: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963.

3.05 JOINTS:

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Discontinue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Clean and remove laitance or other foreign material from bonding surface.
7. Use a bonding agent or epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades, adequate in number and power and with sufficient replacement blades to complete the sawing at the required rate. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks. Remove sludge and cutting debris.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install epoxy-coated smooth dowel bars and support assemblies at joints where indicated. Dowels must be installed vertically perpendicular to the face of joint and horizontally parallel to the top of slab surface. At contraction joints, support dowel bars using dowel basket assemblies. Cut basket tie wires crossing the joint prior to concrete placement. Lubricate one-half of dowel length to prevent concrete bonding to one side of joint.

3.06 WATERSTOPS:

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Provide supports as necessary to maintain proper orientation and alignment. Protect exposed waterstops during progress of the

Work. Prevent direct contact of waterstops with formwork, rebars and other items that could reduce waterstop performance. Use shop-fabricated joints unless approved by the manufacturer to be field-fabricated. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.07 CONCRETE PLACEMENT:

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301 and ACI 309.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Pumping: Comply with ACI 304R and ACI 304.2R, and as follows:

1. Pumping shall not result in separation or loss of materials, nor cause interruptions sufficient to permit loss of plasticity between successive increments.
2. Take samples for testing both at the point of delivery to the pump and at the discharge end. Loss of slump in pumping equipment shall not exceed 2 inches.
3. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe size.
4. Limit maximum size of coarse aggregate to 33% of pipe diameter, and maximum size of well-rounded aggregate to 40% of pipe diameter.

3.08 HOT WEATHER PLACEMENT

A. Follow the recommendations of ACI 301 and ACI 305R and as follows when any of the following conditions occur:
   1. When the temperature is 90ºF (32ºC) or above.
   2. When the temperature is likely to rise above 90ºF (32ºC) within the 24-hour period after concrete placement.
   3. When there is any combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.

B. Maintain concrete temperature below 85ºF (29ºC) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

C. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

D. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305R (Figure 2.1.5) does not exceed 0.2 pound per square foot (1.0 kg per square meter) per hour.

E. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.

F. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.

G. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water-saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After the 24-hour interval, continue curing using one of the following methods:
   1. Moist curing for 6 days.
   2. Application of one coat of curing compound conforming to ASTM C309, Type 2.
   3. Application and maintenance of curing paper or heat-reflecting plastic sheets for 6 more days.

H. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing using one of the following methods:
   1. Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for 6 days.
   2. Strip forms and apply curing compound conforming to ASTM C309R, Type 2.
   3. Do not allow concrete surfaces to dry prior to application of curing compound.

3.09 COLD WEATHER PLACEMENT

A. When the temperature is 40ºF (4.4ºC) or is likely to fall below 40ºF (4.4ºC) during the 24-hour period after concrete placement, follow the recommendations of ACI 301 and ACI 306R and as follows to prevent loss of concrete strength or quality.

B. Minimum temperature for concrete as mixed shall be as indicated on lines 2, 3, and 4 of Table 3.1 of ACI 306R. Maximum temperature for concrete as mixed shall be 10ºF (5.6ºC) greater than the corresponding minimum temperature.

C. Place and maintain concrete so that its temperature is never less than the temperature indicated on line 1 of Table 3.1 of ACI 306R. Maintain the required temperature for the time duration indicated on Tables 5.1 and 5.3 of ACI 306R.

D. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures. Monitor temperature of concrete in place at corners or edges of formwork as applicable.
E. Air Heaters:
   1. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines.
   2. Oil- or coke-burning salamanders will not be permitted.
   3. Heaters shall be ultramatic portable heaters made by the Union Chill Mat Company or Engineer approved equal.
   4. Personnel shall be present at all times to maintain safe, continuous operation of heating system.
F. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.
G. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
H. Calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators will not be permitted to accelerate curing or to thaw frozen subgrade prior to concrete placement.
I. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on Table 5.5 of ACI 306R.
J. Cure the concrete in accordance with Chapter 5 of ACI 306R.

3.10 FINISHING FORMED SURFACES:
A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces not exposed to view.
B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
   1. Apply to concrete surfaces exposed to view.
C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS:
A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
   1. Apply float finish to surfaces to receive trowel or broom finish.
C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of

trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

D. Broom Finish: Apply a broom finish to exterior concrete slabs, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.12 MISCELLANEOUS CONCRETE ITEMS:

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.13 CONCRETE PROTECTING AND CURING:

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 301, ACI 306R for cold-weather protection and ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. per hour before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days.

Immediately repair any holes or tears during curing period using cover material and waterproof tape.

a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid sealer-hardener or epoxy coating.
c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. For surfaces to receive penetrating liquid sealer-hardener or epoxy coating, cure using moisture curing or moisture-retaining cover. Where not practical, use of curing compound is permitted. However, curing compound must be removed prior to application of the penetrating liquid sealer-hardener or epoxy coating.
   b. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer, unless manufacturer certifies curing compound will not interfere with bonding or penetration or sealers used on Project.
4. Curing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS:

A. Penetrating Liquid Sealer-Hardener: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 14 days' old (or longer as required by product manufacturer).
   3. Apply as recommended by product manufacturer (two coats minimum). Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply subsequent coats in a similar manner.
   4. Apply to the surfaces indicated on Contract drawings:
B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.
C. Protect liquid floor treatments from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

3.15 JOINT SEALING:

A. Provide groove of proper width and depth to accommodate back rod and joint sealant.
B. Remove dirt, debris, and saw cuttings from joints; leave contact faces of joint clean and dry.

C. Prepare and install joint sealant according to manufacturer's written instructions.
   1. Defer joint sealing until concrete has aged at least one month.

3.16 CONCRETE SURFACE REPAIRS:

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing. Blend with white Portland cement as necessary to match concrete color. Prepare patching mortar not more than 30 minutes prior to use.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
   2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
   3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, pop-outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around.

Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.17 FIELD QUALITY CONTROL:

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:
1. Formwork.
2. Steel reinforcement and placement.
3. Anchor bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample set for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
3. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content (where applicable): ASTM C231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40ºF and below and when 80ºF and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M.
   a. Cast and laboratory cure three sets of two standard cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.

a. Test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
c. Retain the third set for future testing as necessary.

8. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
13. Additional testing and inspecting, at Subcontractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03 30 00

SECTION 05 05 19 – CONCRETE ANCHORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section includes post installed adhesive anchors, mechanical anchors and epoxy anchorage of rebar in hardened concrete.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

1. Concrete: Section 03 30 00
2. Steel: Section 05 12 00

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   1. International Building Code (IBC), 2021.
   2. American Concrete Institute (ACI):
      a. 318 – Building Code Requirements for Reinforced Concrete.
      b. 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete.
      c. 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete
   3. International Code Council Evaluation Service (ICC-ES)
      a. AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
      b. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
   4. International Association of Plumbing and Mechanical Officials (IAPMO)

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Include but not limited to, the following:
   1. Product specification data with recommended design values and physical characteristics for epoxy dowels, adhesive, expansion and undercut anchors.
   2. Quality Assurance Submittals:
      a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
      b. Certificates:
         (1) ICC ES Evaluation Reports.
   3. Manufacturer's installation instructions.
   4. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.06.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
C. Closeout Submittals: Submit the following:
   1. Record Documents: Project record documents for installed materials in accordance with Division 1 Closeout Submittals Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
   1. All personnel installing adhesive anchors must be ACI adhesive anchor certified with at least three years of experience performing similar installations..

B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the installer on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
   1. hole drilling procedure
   2. hole preparation & cleaning technique
   3. adhesive injection technique & dispenser training / maintenance
   4. rebar dowel preparation and installation
   5. proof loading/torquing

C. Certifications: Unless otherwise authorized by the Engineer, anchors must have one of the following certifications:
   1. ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer's clearly labeled unopened packaging, complete with installation instructions.

B. Protect and handle materials in accordance with manufactures recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS:

2.01 MATERIALS

A. Fasteners and Anchors:
   1. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
   2. Carbon and Alloy Steel Nuts: ASTM A563.
   3. Carbon Steel Washers: ASTM F436.
   4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
   5. Wedge Anchors: ASTM A510; or ASTM A108.
   6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
   7. Stainless Steel Nuts: ASTM F594.
   8. Zinc Plating: ASTM B633.
   9. Hot-Dip Galvanizing: ASTM A153.
   10. ASTM F2329 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
   11. Reinforcing Dowels: ASTM A615

2.02 MECHANICAL ANCHORS

A. Mechanical anchors must meet the qualification criteria of ACI 355.2, ICC-ES AC193 (concrete).

B. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).

C. Exterior Use: Unless otherwise indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

D. The type of anchors must be as follows:
   1. Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers.
      a. Life safety applications (Including but not limited to handrail and direct tension hangers)
         (1) Hilti Kwik Bolt TZ
      b. Low risk to life safety (small pipe stands, Unistrut, etc.)
         (1) Hilti Kwik Bolt 3

2.03 ADHESIVE ANCHORS

A. Adhesive anchors must meet the qualification criteria of ACI 355.4, ICC-ES A308 (concrete).

B. Adhesive anchors must not be installed in concrete less than 21 days of age.

C. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).

D. Exterior Use: Unless otherwise indicated on the Drawings, provide galvanized steel anchors following ASTM A153.

E. Reinforcing dowels must be A615 Grade 60.

F. The type of anchors must be as follows:
   1. Adhesive Anchors – Life safety applications.
      a. Hilti – HIT-HY200 V3
   2. Adhesive Anchors: (Used for non-vibrating equipment anchorage and other non-life safety attachments)
      a. Hilti – HIT-HY200 V3
   3. Epoxy Rebar Dowels:
      a. Hilti HIT-RE500 V3

PART 3 - EXECUTION

3.01 INSTALLATION

A. Drilled-In Anchors:
   1. Drill holes with rotary impact hammer drills using carbide-tipped bits. Drill bits must be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes must be drilled perpendicular to the concrete surface.
      a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
      b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Take precautions as necessary to

avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.

(1) Notify the Engineer prior to abandoning and relocating anchor holes if reinforcing steel or other embedded items are encountered during drilling and the specified embedment depth has not been met.

c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete until concrete has achieved full design strength.

2. Perform anchor installation in accordance with manufacturer instructions.
3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque must be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor must be removed and replaced unless otherwise directed by the Engineer.
4. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive must be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
5. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.02 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements must be regarded as malfunctioning.

3.03 FIELD QUALITY CONTROL

A. Mechanical anchor installation must have periodic special inspection per IBC.
B. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tensions loads must have continuous special inspection per IBC.
   1. All other adhesive anchors not described above must have periodic special inspection per IBC 2021.

END OF SECTION 05 05 19

SECTION 05 12 00 – STEEL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes fabrication and erection of structural steel and other steel or metal items as defined in AISC Manual, Code of Standard Practice.

1.03 RELATED REQUIREMENTS:

A. DIVISION 03, Section 03 30 00 – Cast-In-Place Concrete for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, and other items cast into concrete.

B. DIVISION 05, Section 05 05 19 – Concrete Anchors

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American Institute of Steel Construction:

1. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges.
2. AISC 360 - Specifications for Structural Steel Buildings

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

D. ASTM International:

1. ASTM A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
2. ASTM A36 - Carbon Structural Steel.
3. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. ASTM A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
5. ASTM A108 - Steel Bar, Carbon and Alloy, Cold-Finished.
6. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
7. ASTM A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
8. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware - AASHTO No.: M232.
9. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
10. ASTM A384 - Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
11. ASTM A385 - Providing High-Quality Zinc Coatings (Hot-Dip)
12. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. ASTM A563 - Carbon and Alloy Steel Nuts.
14. ASTM A780 - Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
15. ASTM A786 - Hot-Rolled Carbon Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
16. ASTM A992 - Structural Steel Shapes.

17. ASTM A1011/A1011M - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
18. ASTM B695 - Coatings of Zinc Mechanically Deposited on Iron and Steel.
19. ASTM C1107 - Packaged, Dry Hydraulic Cement Grout (Non-shrink).
20. ASTM F436 - Hardened Steel Washers.
21. ASTM F1554 - Anchor Bolts, Steel, 36-, 55-, and 105-ksi Yield Strength.
22. ASTM F2329 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
23. ASTM F3125 - High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.

E. The National Association of Architectural Metal Manufacturers (NAAMM):
   1. MBG 531 - Metal Bar Grating Manual.
   2. MBG 533 - Welding Specifications for Fabrication of Steel, Aluminum and Stainless-Steel Bar Grating.

F. Occupational Safety and Health Administration:
   1. All applicable OSHA regulations, including, but not limited to 29 CFR Part 1910 and Part 1926 Subpart R - Steel Erection.

G. Research Council on Structural Connections:
   1. RCSC Specification for Structural Joints Using High-Strength Bolts.

H. Society for Protective Coatings:
   1. SSPC SP10 (WAB) / NACE WAB-2 - Near-White Metal Wet Abrasive Blast Cleaning

1.05 SUBMITTALS:

A. Submit as specified in Division 01.

B. Product Data: For each type of product indicated including, but not limited to, floor grating, stair treads and nosings, stud shear connectors, grout, anchors, and protective coatings.

C. Shop Drawings: Show fabrication and installation details for each structure including steel components, connections, anchorage and accessory items. Submit plans, elevations, sections and details.
   1. Reproductions of Engineer-prepared Contract Drawings may not be used.
   2. Fabrication and erection drawings must be grouped in sets or sequences and must be identified separately for each building, structure, or area. Each set or sequence submitted separately must include all drawings referenced within that set or sequence. No drawings shall be submitted in multiple sets or sequences.
   3. In the event that drawing revisions are necessary, fabrication and erection drawings must be clearly clouded showing all changes from the previous revision. Identified sets or sequences must remain consistent throughout all versions.
   4. All necessary information for the fabrication, including connection material specifications and sizes as well as filler metal for welds, of the component part of the structure, presented on drawings must conform to recognized standard practice, AISC Manual and AWS Code.
   5. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars and weld tabs that are to be removed, and supplemental fillet welds where backing bars are to remain.
   6. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

7. Include embedment drawings.
8. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned high-strength bolted connections.
9. Indicate diameter, length, and spacing of shop installed shear connectors.
10. Drawings showing each piece including anchor bolts marked for identification to correspond to erection drawings.

D. Qualification Data: For qualified Erector and Fabricator

E. AWS Certified Welding Inspector Certificates.

F. Qualified welding procedure specifications and procedure qualification test results if welding processes differ from those prequalified by AWS.

G. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers or galvanizing, certifying that shop primers are compatible with top coats.

1.06 QUALITY ASSURANCE:

A. Fabricator Qualifications: Fabricator shall participate in the AISC Certification Program and be designated an AISC Certified Plant, Category BU (formerly known as Category STD).

B. Welder Qualifications:
1. Welders must be previously qualified by passing the tests prescribed in AWS D1.1 or by passing such other tests as Engineer may accept.
2. Welders must have been tested within the past 12 months, and their qualification must be considered as remaining in effect unless the welder is not engaged in a given process of welding for a period exceeding 6 months.

C. Welding Qualifications:
1. Qualify welding procedures according to AWS D1.1, AWS D1.2 or AWS D1.6 as applicable.

D. Inspection: Material or workmanship may be subject to inspection in the shop and field. Engineer must be granted access to fabrication facilities and erection site at all times while work is being performed.

E. Comply with applicable provisions of the following specifications and documents:
1. AISC 303.
2. AISC 360.
3. RCSC "Specification for Structural Joints Using High-Strength Bolts."
4. OSHA regulations, including, but not limited to, 29 CFR Part 1910 and Part 1926 Subpart R - Steel Erection.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Handle and store all steel and appurtenances as specified in Division 01.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
2. All steel and its coatings must be protected from damage caused by handling, storage, and shipping.

3. Protect all items with shop applied protective coatings from corrosion. Store in an environment and manner consistent with type of coating.

C. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 fasteners and for retesting fasteners after lubrication.

D. All materials and documentation must be inspected immediately upon receipt at the erection site to determine that all items in the bill of material have been supplied, to assure that all documentation has been received, and to check for any damage.

1.08 COORDINATION:

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

C. Field Measurements: Verify actual locations of walls and other existing construction contiguous with steel fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS:

A. Steel: Conform to the following unless otherwise indicated or specified.
   1. Wide flange (W) shapes and tees cut from W and Channels 8 inches or greater: ASTM A992.
   2. Channels less than 8 inches: ASTM A36.
   3. Plates, angles and bars: ASTM A572.
   4. Hollow Structural Sections: ASTM A1085.
   5. Steel Pipe: ASTM A53, Type E or S, Grade B.
      a. Weight Class: Standard unless indicated otherwise.
      b. Finish: Galvanized unless indicated otherwise.

B. Floor Grating:
   1. Steel: Conform to ASTM A1011, Commercial Steel (Type B).

C. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of channels: 1-5/8 by 1-5/8 inches or as indicated.
   2. Material: Cold-rolled steel, ASTM A1008, structural steel, Grade 33; 0.0677-inch nominal thickness; hot-dip galvanized after fabrication unless indicated otherwise.

2.02 CONNECTION BOLTS, NUTS, AND ANCHORS:

A. High-strength Bolts, Nuts and Washers must conform to one of the following installations:
   1. Conform to ASTM F3125, Grade A325, Type 1 Heavy Hex Head Style with hot dipped zinc coating.

2. Provide Galvanized Direct-Tension Indicator Washers conforming to ASTM F959 or Tension Control Bolts conforming to ASTM F3125, Grade F1852, Type 1, twistoff style assemblies consisting of steel structural bolts with splined ends.
3. All Bolts, Nuts, washers and direct-tension indicators must be galvanized when indicated or connecting galvanized steel.
4. Nuts: Heavy hex conforming to ASTM A563 Grade C.
5. Flat and beveled washers: Conform to ASTM F436, Type 1.

B. Unheaded Anchor Rods:
1. Conform to ASTM F1554, Grade 36, unless otherwise indicated. With ASTM A563 heavy-hex nuts.
2. Washers:
a. For ASTM F1554 Bolts: Conform to F436.

C. Finish: Plain, unless indicated otherwise. Where indicated to be galvanized or when connecting to galvanized steel, provide hot-dip zinc coating in accordance with ASTM A153, Class C and ASTM F2329. Galvanize all anchor bolts, nuts, and washers except stainless steel.

D.

E. Threaded Rods: Conform to ASTM A36 unless indicated otherwise.
1. Nuts: ASTM A563 heavy-hex carbon steel.
2. Washers: ASTM F436, Type 1 hardened carbon steel.
3. Finish: Plain unless indicated to be galvanized. Hot-dip zinc coating, ASTM A153, Class C where indicated.

F. Welding Electrodes:
1. For ASTM A36 steel, use E70 electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1 AWS D1.1.
2. For ASTM A572, Grade 50 steel or ASTM A992 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1, AWS D1.1.

G. Galvanizing:
1. Conform to ASTM A123.
2. When required to be galvanized, nuts, bolts, and washers must be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.

2.03 MISCELLANEOUS MATERIALS

A. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780 and compatible with paints specified to be used over it.

2.04 NON-SHRINK GROUT:

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.05 STEEL FABRICATION, GENERAL:

A. Fabricate all steel to conform to AISC 303, AISC 360, and applicable portions of OSHA 29 CFR Part 1910 and Part 1926.

B. Fabricate and assemble in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Camber structural-steel members where indicated. Fabricate beams with rolling camber up.

D. Permissible variations for sweep, camber, length, and cross section of all steel members must conform to ASTM A6, AISC Manual, Part 1 and AISC Code of Standard Practice unless indicated otherwise.

E. Field-measure existing steel and structures where necessary to ensure fabrication fit-up of new steel.

F. All pieces must be clearly marked with a permanent identifying erection mark number. Method and location of marking must be approved by Engineer. Erection markings for galvanized steel must be mechanically stamped on steel tags with 1/8-inch minimum thickness. Tags must be bent to provide clearance for galvanizing between the member and the tag, except at the tag ends. Tag ends must be welded to the member.
   1. Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

G. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

H. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut holes or enlarge holes by burning.
   2. Base Plate Holes: Cut, drill, or punch holes perpendicular to steel surfaces. Provide grout holes in all base plates with least dimension greater than 24 inches (600 mm), as close to center as practicable and with minimum diameter of 2 inches (50 mm).
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

J. Weep Holes – Drill adequate drainage holes to eliminate water traps. Hole diameter must be ¾ inch and located indicated on the detail drawings. Hole size and locations must not affect the structural integrity.

K. Vent Holes – Provide vent holes as required for hot dipped galvanizing. All vent holes must be plugged with zinc plugs after hot dipped galvanizing process.

L. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

M. Shop Connections:
   1. Weld or bolt except when otherwise indicated or specified.
   2. Shop welded connections may be used in lieu of bolted connections with Engineer approval.
   3. Welded connections: Comply with AWS D1.1 (or D1.2 or D1.6 as applicable) for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
      a. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

b. Welds of connection angles to beam webs must conform to AISC Manual, Part 10, Table 10-2 with particular regard for minimum web thickness. Provide longer connection angles or reinforce web as required.
c. All butt-joint groove welds must be complete penetration welds unless otherwise indicated and must conform to the applicable standards in AISC Manual, Part 8, with special emphasis on maintaining root opening. Accomplish this for single-bevel, butt-joint welds by using backup plates or by chipping out and welding on the opposite side.
d. Prepare weld bevels with a mechanically guided cutting torch or by grinding.

4. Bolted connections: Shop install high-strength bolts according to RCSC "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
a. All bolted connections must be made with Pretensioned connections using 3/4-inch bolts, nuts, and washers, unless otherwise indicated or specified.
b. Use the minimum number of rows of bolts for beam connections so that bottom row is at or below the centerline of the beam.
c. Bolts to be installed in the shop must be tightened in accordance with the provisions for field connections in PART 3.

N. Provisions for Field Connections:
1. Provide bolted connections unless otherwise indicated or specified. The number of rows and number of bolts indicated on the Drawings or stated in the Specifications is the minimum number of rows or bolts. Provide additional bolts or connection devices, if necessary, to comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
2. Provide for field welding only when so indicated or where approved by Engineer.
3. Provide all members to be field-welded with bolted erection connections adequate to resist erection stresses prior to field welding.

O. Comply with OSHA 29 CFR 1926, Subpart R - Steel Erection.

2.06 COLUMN BASE AND EQUIPMENT ANCHOR BOLTS:

A. Furnish for all columns and equipment furnished and installed under this Contract, (and as required to install all equipment furnished by others for installation under this Contract unless otherwise indicated).

2.07 MISCELLANEOUS FRAMING AND SUPPORTS:

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
1. Fabricate units from slotted channel framing where indicated.
C. Galvanize miscellaneous metal framing and supports where indicated.

2.08 METAL GUARD POSTS:

A. Fabricate metal guard posts from Standard weight steel pipes.
B. Prime guard posts after hot-dipped galvanizing.

2.09 GUARDRAIL AND HANDRAIL:

A. Where indicated as pipe: 1-1/2-inch nominal (1.9-inch OD) round, standard-weight pipe.
B. Where indicated as angle: angle sizes for posts and railing as indicated.
C. Post spacing must not exceed 4.5 feet from center-to-center.
D. Form and weld all pipe railing. Grind all welds smooth and even with the surface of the pipe, including field welds required for erection.
E. Carefully form all pipe railing where change of direction or elevation occurs.
F. Guardrail posts must be vertical (plumb) unless otherwise indicated.
G. Include kick plates at the edge of uncovered openings and the perimeter of walkways and platforms, except as otherwise indicated.
H. After galvanizing, fill all vent holes with matching zinc plugs. Bottom weep holes must be left open to prevent moisture build-up.

2.10 EDGE ANGLES, PLATES:

A. Furnish around and over openings as indicated.
B. Keep plates and edge angles flush at intersections and fillet-weld to give a neat appearance at the exposed intersecting surfaces.
C. Properly align, level, and plumb edge angles and plates before concrete is placed.

2.11 KICK PLATES:

A. Furnish at the edge of uncovered openings, including all pipe and port penetrations, and at the edge of walkways and platforms, except as otherwise indicated.

2.12 FLOOR GRATING:

A. Steel bar grating: One-piece, resistance-welded, carbon-steel construction without notching of bearing or cross bars before welding and conforming to NAAMM MBG 531.
    1. Main Bearing Bars:
        a. Thickness: 3/16 inch; 3/8 inch for heavy duty grating, unless indicated otherwise.
        b. Depth: As indicated.
        c. Spacing: Not more than 1-3/16 inches on center; 1-3/8 inches on center for heavy duty grating.
    2. Cross Bars: Welded cross bars spaced at 4 inches maximum.
    3. Cross Bars: Swaged cross bars spaced at 4 inches maximum.
B. Configuration of top surface of main bars unless otherwise indicated:
        a. Exterior - Exposed to Weather: Serrated.
C. Fabrication:
    1. Fabrication must conform to NAAMM MBG 531and MBG 533.
    2. Crossbars must match crossbars of adjacent sections to form a continuous pattern of straight lines.
    3. Provide all openings in grating indicated and as required for installation of all piping, wiring, and equipment installed under this Contract.
    4. Band all openings 4 inches and larger with a metal bar same thickness as the main bearing bar and extend 4 inches above top of grating, unless indicated otherwise. Bottom of band bars must extend to the same depth as bearing bars. Weld to each bearing bar with a 3/16-inch fillet weld 3/4 inch long. Tack weld to all crossbars.
    5. Trim-band all locations as follows:
        a. Open end of grating at head of a ladder.
        b. Manway opening.

c. Hinged sections.
d. Grating panels with four crossbars or less.
e. Other locations as indicated.

6. Provide kickplates where indicated and at all handrail on floors or platforms 4 foot or more above adjacent floors or ground where persons can pass or machinery is located.

D. Shop Finish:
1. Hot-dip galvanize steel grating after fabrication, except where otherwise indicated..

E. Provisions for Grating Connections:
1. Provide clamps or clips to anchor the grating securely to supports. A minimum of 4 fasteners per panel must be provided, unless indicated otherwise on the drawings.
2. Where indicated to be removable, provide fasteners designed to allow removal of grating panels in the future.
3. Finish of grating fasteners must match finish of grating.

2.13 STAIRS:

A. General Construction:
1. Stringer sizes indicated are minimum acceptable size.
2. Cross-brace stringers to provide lateral stability as indicated and where the horizontal run exceeds 12 feet.
3. Provide struts and hangers where indicated or as otherwise required for proper support.

B. Treads:
1. Open-riser type with grating conforming to PART 2 - Steel Floor Grating, this Section, and of the same type as specified herein, with main bars 1 inch by 3/16 inch unless indicated otherwise.
2. Treads damaged during construction must be replaced immediately.
3. Nosings for grating stair treads must be standard checkered-plate nosing, unless indicated otherwise. Coating must be same as specified for stair treads. Attach to treads by welding.
4. Bolt tread to each stringer with a minimum of two 3/8-inch bolts.

C. Grating Landings:
1. Landings must be of grating conforming to PART 2 - Steel Floor Grating, this Section.

2.14 COLORS:

A. After galvanizing per section 2.15, paint the following items Safety Yellow following protective coating system B-4 procedures:
1. Guardrails and Handrails.
2. Kick-Plates
3. Stationary Hazards
4. Submit Safety Yellow Color for Approval to the Contractor, Port of Portland and Owner prior to application of Shop-Protective Coating.

B. After galvanizing per section 2.15, paint remaining structural steel items not indicated above Surf Green (Sherwin Williams 6473) following protective coating system B-4 procedures.
1. Submit Seafoam Green color for Approval to the Contractor, Port of Portland and Owner for approval prior to application of Shop-Protective Coating.

2.15 GALVANIZING:

A. General:
   1. Galvanize all steel (including structural steel members, grating, floor plate, and fasteners) after fabrication where indicated.
   2. Conform to ASTM A123 for structural shapes and plates.
   3. Nuts, bolts, and washers must be hot-dip galvanized to conform to ASTM A153.

B. Fabrication:
   1. Safeguard against embrittlement in accordance with ASTM A143.
   2. Safeguard against warping and distortion in accordance with ASTM A384.
   3. Fabrication details must be in accordance with ASTM A385 to allow for the creation of high quality zinc coatings.
   4. Cutting, drilling, and welding must be performed before galvanizing.
   5. Weld slag must be removed before galvanizing.
   6. Edges of tightly contacting surfaces must be seal welded using minimum 1/8-inch fillet welds.
   7. Vent holes must be provided for piping or tubular assemblies (including guardrail and handrail) as required by ASTM A385. Unless indicated otherwise, locate vent holes on the underside of horizontal members where possible.
   8. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
   9. Where surface is to be painted after galvanizing, do not quench or apply post-galvanizing treatments that might interfere with paint adhesion. After galvanizing, thoroughly clean of grease, dirt, oil, flux and other foreign matter, and treat with metallic phosphate process.
   10. Potential issues which could cause a problem in galvanizing must be brought to the Engineer's attention prior to galvanizing.

C. Galvanizing of Steel Hardware:
   1. Nuts must be tapped oversize in accordance with ASTM A563.
   2. Nut threads must be re-tapped after hot-dip galvanizing to provide proper fit.
   3. Direct tension indicators must be mechanically galvanized by the manufacturer in accordance with Class 50 of ASTM B695.

D. Repair:
   1. Any damage to galvanizing must be repaired in accordance with ASTM A780.
   2. Before repair of damaged galvanized coating, exposed substrate metal must be cleaned to bright metal and free of all visual rust, oil, or grease. Any non-adhering galvanizing must be removed to the extent that the surrounding galvanizing is integral and adherent.
   3. If surface defects exceed 2% of a member's area, the defects must be repaired by re-dipping the member in the zinc bath.
   4. Cold repair using an organic zinc rich coating must be permitted if the following conditions exist:
      a. Total damaged area is less than 1% of the total coated area of the member being repaired.
      b. No single repair is greater than 2 square inches (1300 mm^2).
      c. No single repair is greater than 12 inches (300 mm) long.
   5. For cold repair:
      a. Repair areas in accordance with ASTM A780, Method A2.

b. Apply organic zinc-rich primer containing a minimum of 93% zinc in dry film by weight. Apply in multiple coats (allowing proper recoat time) to achieve 8-mil dry film thickness.
c. Color and sheen must approximately match the color of galvanizing.
d. Do not use any products containing lead.

6. Hot repairs must be made in the shop if any of the following conditions exist:
   a. Total damaged area is greater than 1% but less than 2% of the total coated area of the member being repaired.
   b. Any single repair is at least 2 square inches (1300 mm^2) in area.
   c. Any single repair is 12 inches (300 mm) long or more.
7. Hot repair must be made using zinc alloy rod or powder manufactured for the repair of galvanized steel. Do not use any products containing lead.
8. Flux, heavy ash, or heavy dross inclusions must be removed by brushing, grinding, or filing as required.
9. Galvanized steel which has been rejected must be stripped, regalvanized, and submitted again for inspection.
10. Correction of excessive warpage that exceeds ASTM A6/A6M criteria must be performed by press straightening if possible.
11. The application of localized heating to straighten must be approved by Engineer.

2.16 SHOP-PROTECTIVE COATING:

A. Coat all galvanized steel as indicated in SECTION 2.15, then coat galvanized steel per protective coating system B-4 procedures.
B. Coating must not exceed specified mil thickness by more than 20%. If this tolerance is exceeded, take corrective action and ensure compatibility with finish coats.
C. Acceptable paint manufacturer's must be as indicated in protective coating system B-4 procedures.

2.17 SOURCE QUALITY CONTROL:

A. Bolted Connections: Shop-bolted connections must be tested and inspected according to RCSC "Specification for Structural Joints Using High-Strength Bolts."
B. Welded Connections: All shop-welded connections must be visually inspected. In addition to visual inspection, all complete joint penetration (CJP) shop-welded connections must be inspected using ultrasonic testing. At the request of the testing agency, other welds may also be tested and inspected according to AWS D1.1 (or D1.2 or D1.6 as applicable) and the following inspection procedures, at testing agency's option:
   1. Liquid Penetrant Inspection: ASTM E165.
   2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. Ultrasonic Inspection: ASTM E164.
   4. Radiographic Inspection: ASTM E94.In addition to visual inspection, shop-welded shear connectors must be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   5. Bend tests must be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   6.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Field-check location and elevation of column anchor bolts and foundations before erecting structural steel columns and posts.
B. Verify, with Installer present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
C. Field-measure existing steel for plumbness and elevation at connecting points.
D. Proceed with installation only after unsatisfactory conditions have been corrected.
E. Assure that all preassemblies not specifically indicated on Contract Drawings to be preassembled before lifting must maintain structural integrity during lifting.

3.02 STEEL ERECTION:

A. Erect all steel to conform to AISC specifications, codes, and standards or any local, state or federal codes which may exceed such requirements. Comply with applicable OSHA regulations including 29 CFR 1926, Subpart R - Steel Erection.
B. Protect existing structure from weather when connecting steel to existing structure.
C. Protect steel and anchor bolt sleeves from entrapped water that can cause damage from freezing or corrosion.
D. Maintain erection tolerances of structural steel in accordance with AISC 303.
E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
    1. Level and plumb individual members of structure.
F. Splice members only where indicated. Where not indicated but necessary, proposed splice location and details must be submitted for approval by Engineer.
G. Do not use thermal cutting during erection.
H. Do not enlarge unfair holes in members by burning or using drift pins. Holes may be filled with weld metal, ground smooth and field drilled to correct.
I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
J. Base, Bearing and Leveling Plates:
    1. Prior to setting base plates, clean out sleeves of all foreign material and liquid. Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.
    2. Set plates for structural members on wedges, shims, or setting nuts as required.
    3. Weld plate washers to top of base plate where required.
    4. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before grouting.
    5. Grout under base plates with a flowable or dry-pack shrinkage resistant grout, taking special care not to disturb their grade and alignment.

6. Neatly finish exposed surfaces at 45-degree slope after grout has attained initial set; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouts.
7. In hot or cold weather conform to manufacturer's recommendations for temperature control for grouting operations.

K. Erection Bracing:
1. Provide all necessary erection bracing and be responsible for structural adequacy, design, engineering, and construction of erection bracing.
2. Provide all necessary temporary struts, ties, cables, temporary flooring, planking, and scaffolding in connection with the erection of the structural steel or support of erection machinery.
3. Place as required to maintain proper position against loads from erection equipment, construction material, and wind.
4. Leave bracing in place until sufficient steel connections, concrete slabs, exterior walls, and roof decks are in place to ensure stability of the structure.

L. Connections:
1. Bolted Connections: Install high-strength bolts according to RCSC "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
2. Provide direct tension indicator washers in all ASTM F3125, Grade A325 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.
3. When utilizing Tension Control Bolts, bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.
4. Where required for connection fit-up, bolt holes may be adjusted in one of the following manners (flame cutting or flame enlargement of holes is not allowed):
   a. Holes may be filled with weld metal, ground smooth, and field-drilled.
   b. Other Engineer-approved method.
5. Welded Connections: Comply with AWS D1.1 (or D1.2 or D1.6 as applicable) for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   a. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   b. Make welded connections as indicated and leave all erection bolts in place after completion of welding unless otherwise indicated.
   c. Reinforce connections when members requiring fillet welds are not in contact.
   d. Use backup bars or spacer bars on all butt welds where root opening exceeds 3/16-inch.
   e. Remove all backing bars or runoff tabs, back gouge, and grind steel smooth.

M. Protect pipe sleeves, other anchorage members, and concrete bases from deleterious materials at all times, and from water which may cause ice damage during freezing weather.

3.03 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS:

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Install pipe supports and posts on concrete footings with grouted baseplates. Position and grout baseplates as specified in "Steel Erection" Article, this Section.

3.04 INSTALLING GUARDRAIL AND HANDRAIL:

1. Form and weld all pipe railing. Grind all welds smooth and even with the surface of the pipe.
2. Carefully fit all pipe railing where change of direction or elevation occurs.
3. Install all rails and posts plumb, level, straight and true, and in alignment.
4. Top rail must clear all fixed objects by at least 3 inches vertically and horizontally.
5. Furnish and install plates, bolts, and additional items as indicated or required for fastening to supporting members.

3.05 INSTALLING FLOOR GRATING:

1. Grating installation must conform to NAAMM MBG 531 and as specified herein.
2. Space fasteners as required to overcome irregularities and maintain grating contact with supports. Minimum anchorage of each panel must be two fasteners at each support.
3. Install grating fasteners per manufacturer's printed instructions.
4. All grating must be removable unless otherwise indicated.

3.06 INSTALLING METAL GUARD POSTS:

A. Anchor guard posts in place with concrete foundations as indicated. Center and align guard posts in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace guard posts in position until concrete has cured.

B. Fill guard posts solidly with concrete, mounding up top surface to shed water.

3.07 INSTALLING CONCRETE ANCHORS:

1. Install anchors to conform to manufacturer's printed instructions.
2. The hole tolerances, drill bits, and anchor installation torque must be as per manufacturer's printed recommendations.

3.08 FIELD QUALITY CONTROL:

A. Testing and Inspecting: Contractor will engage a special inspector and qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Special Inspections:
   1. Verify structural steel materials and inspect steel frame joint details.
   2. Verify weld materials and inspect welds.
   3. Verify connection materials and inspect high-strength bolted connections.

C. Bolted Connections: Bolted connections will be tested and inspected according to RCSC "Specification for Structural Joints Using High-Strength Bolts."

D. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
   1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
      a. Liquid Penetrant Inspection: ASTM E165.
      b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      c. Ultrasonic Inspection: ASTM E164.
      d. Radiographic Inspection: ASTM E94.

E. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.09 FIELD-PROTECTIVE COATINGS:

A. Surface Preparation: Prepare all surfaces by SSPC SP10 (WAB) / NACE WAB-2.
B. Clean all shop-coated surfaces damaged from rust and mill scale, welding, and abrasion.
C. Field-Spotting Coat:
   1. Apply to all unpainted, damaged, or cleaned parts of the steel furnished under this Contract including unpainted portions of field-welded and bolted connections.
D. Existing Steel Field Recoating:
   1. Prepare and recoat the following items “Bright White” following protective coating system A-4 procedures:
      a. Existing Pump Pad Structural Steel
      b. Existing Pump Pad Baseplates
      c. Existing Pump Pad Anchor Bolts
      d. Existing Pump Pad Structural Steel Connections and Bolts
   2. Prepare and recoat the following items “Safety Yellow” following protective coating system A-4 procedures:
      a. Existing Pump Pad Guardrail and Handrail
      b. Existing Pump Pad Kickplate
E. Coating must not exceed specified mil thickness by more than 20%. If this tolerance is exceeded, take corrective action and ensure compatibility with finish coats.
F. Acceptable paint manufacturer’s must be as indicated in protective coating system A-4 procedures.

3.10 REPAIR OF GALVANIZED SURFACES:

A. Clean and repair all surfaces where galvanizing is missing or damaged in accordance with ASTM A780 and the "Galvanizing" paragraph in PART 2, this Section.

END OF SECTION 05 12 00

BURNS McDONNELL

PROTECTIVE COATING SYSTEM

System: B-4

SERVICE:	Nonferrous & Galvanized Metal — Moderate to Severe Exposure Exterior or Interior (Including Galvanized Handrail)
Surface Preparation:	Shop or field first coat: Remove oil or soap film with neutral detergent or emulsion cleaner.
First Coat:	Pretreat and/or allow to weather as recommended by coating manufacturer.
Second Coat:	High build polyamide or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 - 6.0 mils (100 -150 microns) dry film thickness.
Third Coat:	High solids aliphatic acrylic polyurethane gloss enamel with minimum 60% solids by volume. Apply at 2.0 – 3.0 mils (50 – 75 microns) dry film thickness.
System Total:	Minimum 6.0 mils (150 microns) dry film thickness in addition to galvanizing.
Volatile Organic Content:	Maximum 2.8 lb/gal (340 g/L).

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	**TOUCH UP**	**SECOND COAT**	**THIRD COAT**
PPG	See above		Amercoat 385	Amercoat 450 H
Carboline	See above		Carboguard 893 SG	Carbothane 134 HG
Ceilcote	See above		650FDA Ceilgard	477 Ceilgard
Devoe - AkzoNobel	See above		Devran 220	Devthane 389
International	See above		Intergard 475 HS	Interthane 990 Series
ITW Devcon Futura	See above		Flexshield Primer 4484	Flexshield 1000
Sherwin-Williams	See above		Macropoxy 646 B58-600 Series	HS Polyurethane B65-300 Series
Tnemec	See above		F.C. Typoxy Series 27	Endura-Shield II 1074

SECTION 07 11 13 – BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Cold-applied, emulsified-asphalt dampproofing.

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:
   1. ASTM C 272 - Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
   2. ASTM C 578 - Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   3. ASTM D 41 - Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   4. ASTM D 449 - Specification for Asphalt Used in Dampproofing, and Waterproofing.
   5. ASTM D 1227 - Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
   6. ASTM D 1621 - Test Method for Compressive Properties of Rigid Cellular Plastics.
   7. ASTM D 1668 - Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.
   8. ASTM D 4263 - Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   9. ASTM D 4479 - Specification for Asphalt Roof Coatings – Asbestos-Free.
   10. ASTM D 6380 - Specification for Asphalt Roll Roofing (Organic Felt).

C. Code of Federal Regulations:
   1. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.

D. Model Building Codes:
   1. International Code Council. International Building Code 2006. Falls Church, VA: ICC, 2009.

E. National Roofing Contractors Association:
   1. The NRCA Waterproofing Manual. Rosemont, Ill: NRCA, 2005.

1.04 SUBMITTALS:

A. Product Data: For each type of product.

1.05 FIELD CONDITIONS:

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide protection course and auxiliary materials recommended in writing by manufacturer of primary materials.

B. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise required.

2.02 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. APOC, Inc.; a division of Gardner-Gibson.
   2. BASF Construction Chemicals - Building Systems; Sonneborn Brand Products.
   3. Brewer Company (The).
   4. ChemMasters, Inc.
   5. Euclid Chemical Company (The); an RPM company.
   6. Gardner-Gibson, Inc.
   7. Henry Company.
   8. Karnak Corporation.
   9. Koppers Inc.
   10. Malarkey Roofing Products.
   11. Meadows, W. R., Inc.

B. Trowel Coats: ASTM D1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D1227, Type II, Class 1.

D. Brush and Spray Coats: ASTM D1227, Type III, Class 1.

E. VOC Content: 30 g/L or less.

2.03 AUXILIARY MATERIALS:

A. General: Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Emulsified-Asphalt Primer: ASTM D1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

C. Asphalt-Coated Glass Fabric Reinforcement: ASTM D1668, Type I.

D. Patching Compound: Asbestos-free fibered mastic of type recommended in writing by dampproofing manufacturer.

E. Protection Course: Non-woven geotextile fabric composed of polypropylene fibers manufactured into a non-raveling fabric with uniform thickness and strength. Geotextile fabric shall have a minimum weight of 16 oz./sq. yd.

PART 3 - EXECUTION

3.01 EXAMINATION:

1. Examine substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness, surface moisture, and other conditions affecting

performance of bituminous dampproofing work.Test for surface moisture according to ASTM D4263 if required by the manufacturer.
Prepare surface in accordance with manufacturer's recommendations.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.
B. Clean substrates of projections and substances detrimental to the dampproofing work; fill voids, seal joints, and remove bond breakers if any, as recommended in writing by prime material manufacturer.
C. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.03 APPLICATION, GENERAL:

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless more stringent requirements are indicated.
   1. Apply dampproofing to provide continuous plane of protection.
   2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.
B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
   1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8 inch wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

3.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING:

A. Concrete Foundations and Walls: Apply two brush or spray coats at not less than 30 mil each for a total thickness of 60 mil dry film thickness.
B. Reinforce all inside and outside corners with a layer of glass fabric reinforcement embedded in the first coat. Extend a minimum of 12 inches on each side of corners.

3.05 INSTALLATION OF PROTECTION COURSE:

A. Install protection course over completed-and-cured dampproofing. Comply with dampproofing-material and protection-course manufacturers' written instructions for attaching protection course.
   1. Install protection course within 24 hours of installation of dampproofing (while coating is tacky) to ensure adhesion.

3.06 CLEANING:

A. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 07 11 13

DIVISION 21 – FIRE SUPPRESSION

SECTION 211313 - AUTOMATIC SPRINKLER SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Furnish all labor, materials, and equipment for fully operating fire protection systems in full compliance with the applicable NFPA standards and all other codes, regulations, and laws applicable to the work, and in full compliance with the intent of the plans and specifications, including all work inferable from same.

B. Section Includes:

1. Connect to flanged connection on the water service piping inside the building as provided under DIVISION 22.
2. Wet pipe sprinkler systems throughout heated areas of the building.
3. Pipes, fittings, couplings, and specialties.
4. Fire protection valves.
5. Fire department connections.
6. Sprinklers.
7. Monitoring and Alarm devices.
8. Pressure gauges.
9. Inspector’s test valves and piping.
10. Drain valves and piping.
11. System testing.

C. Pay for all necessary construction permits related to the fire sprinkler system.

D. Related Sections:

1. SECTION 21 13 39 - FOAM-WATER SYSTEMS for AFFF piping.
2. SECTION 21 31 16 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS
3. SECTION 28 31 00 - FIRE ALARM SYSTEMS for monitoring of sprinkler systems.

1.03 REFERENCES:

A. Applicable Codes and Standards (latest edition or as adopted by local jurisdiction):

1. 2022 Portland Specialty Structural code (PBC)
2. 2022 Portland Fire Code (PFC)
3. Local Codes including local policies, interpretation, and standards.
4. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI).
   a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
5. American Water Works Association (AWWA).
   a. AWWA C110 - Ductile-Iron and Gray-Iron Fittings for Water.
   b. AWWA C606 - Grooved and Shouldered Joints.
6. American Welding Society (AWS).
   a. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
   b. AWS D10.12 - Guide for Welding Mild Steel Pipe.
7. ASME International (ASME):
   a. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications".
   b. ASME A13.1 - Scheme for the Identification of Piping Systems.

c. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
d. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
e. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Inch Standard.
f. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
g. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
h. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
i. ASME B31.9 - Building Services Piping.

8. ASTM International (ASTM).
   a. ASTM A47 - Specification for Ferritic Malleable Iron Castings.
   b. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. ASTM A135 - Specification for Electric-Resistance-Welded Steel Pipe.
   d. ASTM A234 - Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
   e. ASTM A403 - Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   f. ASTM A536 - Specification for Ductile Iron Castings.
   g. ASTM A795 - Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
   h. ASTM E2016 – Standard Specification for Industrial Woven Wire Cloth.
9. Foundation for Cross-Connection Control and Hydraulic Research (FCCCHR):
   a. List of Approved Backflow Prevention Assemblies (updated online).
10. FM Global (FM):
    a. FM Approvals - Approval Guide.
11. MSS (Manufacturer's Standardization Society) of the Valve and Fitting Industry, Inc.
    a. MSS SP-80 (2019) - Bronze Gate, Globe, Angle, and Check Valves.
12. NFPA (National Fire Protection Association) - Latest edition or as adopted by local jurisdiction:
    a. NFPA 13 – Standard for the Installation of Sprinkler Systems (2019).
    b. NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances (2019).
    c. NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (2020).
    d. NFPA 70 - National Electrical Code (2020).
    e. NFPA 72 – National Fire Alarm and Signaling Code (2019).
    f. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants (2019).
    g. NFPA 1963 – Standard for Fire Hose Connections (2022).
13. Underwriters Laboratories Inc. (UL):
    a. Fire Protection Equipment Directory.

1.04 DEFINITIONS:

A. References to the Fire Protection Engineer in this SECTION means:
   1. A registered professional engineer (P.E.), experienced in the design of automatic sprinkler systems and registered in the project State, who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES) and has relevant fire protection experience.

B. References to the Fire Protection Technician in this SECTION means:

1. A qualified fire protection technician certified at Level III with the National Institute for Certification in Engineering Technologies (NICET) in Water Based Systems Layout.

C. References to the Authority Having Jurisdiction in this SECTION mean:
1. The City of Portland Fire Marshal.
2. PDX Airport Authority.

1.05 PERFORMANCE REQUIREMENTS:

A. Sprinkler system design shall be approved by the Engineer and Authorities Having Jurisdiction (AHJ).
1. See plans for sprinkler system design criteria.

B. Seismic Performance: Sprinkler piping shall be designed to withstand the effects of earthquakes using the methods of NFPA 13, *Protection of Piping Against Damage Where Subject to Earthquakes,* and ASCE/SEI 7. Bracing design shall utilize the S_s value indicated on the structural plans and specifications.

1.06 ACTION SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.

B. Submit Shop Drawings: Include working plans, product data sheets, and hydraulic calculations. Prepare working plans, product data sheets, and hydraulic calculations for the complete sprinkler system in accordance with NFPA 13.
1. Employ the services of a Fire Protection Technician and Fire Protection Engineer. The Fire Protection Technician shall prepare the sprinkler system shop drawings and hydraulic calculations for submittal. The Fire Protection Engineer shall directly oversee the design and sign and seal the shop drawings and calculations for submittal.
2. Employ the services of a Fire Protection Engineer to prepare, sign, and seal the sprinkler system shop drawings and hydraulic calculations for submittal.
3. Employ the services of a Fire Protection Technician to prepare, sign and certify the sprinkler system shop drawings and hydraulic calculations for submittal.
4. The shop drawings, including resubmittals, shall be submitted as a complete submittal package including, but not limited to, shop drawings/working plans, annotated cut sheets, and hydraulic calculations. Partial submittals and submittals not fully complying with the requirements and recommended practices of NFPA 13 and this SECTION will be returned disapproved without review.
5. Shop drawing plans shall be drawn at a minimum scale of 1/8” = 1’-0”.
6. Where the drawings or Part 3 of this specification indicate maximum loads on structural members, shop drawings shall include calculations to indicate maximum hanger loads. Detailed requirements shall be provided on the drawings to indicate maximum hanger spacing where maximum loads require hanger spacing less than maximums allowed by NFPA 13.
7. Product data sheets shall be included for all materials used. Product data sheets shall be annotated to indicate the exact model, size, finishes, and other options that will be provided. Data sheets with multiple models, options and sizes that are not annotated will not be accepted. Outdated or poorly reproduced cut sheets will not be accepted.
8. Include hydrant flow test information with shop drawing submittal.
9. Include the most recent fire pump test information with shop drawings submittal.
10. The shop drawings shall include sway bracing calculations, locations of braces and flexible couplings, and clearance requirements.
11. Provide fire stopping details, with UL system numbers, for penetration through fire and smoke walls, barriers, and partitions.

12. Coordinate with other subcontractors to provide data sheets and details for items that may not be included in the Fire Protection Subcontractor's contract but are necessary for review of the shop drawings. This includes water service piping into the building, backflow preventers located outside the building, new underground piping, etc.
13. Shop drawings shall indicate the extent of the work area and shall indicate all work required as part of the contract.
14. Shop drawings shall be wholly generated and coordinated by the Fire Protection Subcontractor. Partial or complete reproductions of the Engineer's drawings will not be accepted.
15. Shop drawing resubmittals shall be accompanied by a response letter addressing each comment in the Engineer's review of the shop drawings. Changes to the working plans shall be clouded to indicate the revised area and annotated to indicate the revision number and revision date.
16. Submit shop drawings and hydraulic calculations as specified in DIVISION 01 SUBMITTALS to the Engineer for review.
17. Submit shop drawings and hydraulic calculations to the following entities for review:
18. After receiving approval from the Engineer, submit shop drawings and hydraulic calculations to the following entities for review:
    a. The City of Portland, OR.
    b. PDX Airport Authority.

C. Obtain all approvals prior to purchasing equipment or beginning installation.
D. The Fire Protection Subcontractor assumes sole responsibility for purchasing equipment or beginning installation before all approvals are obtained. No change orders will be awarded due to purchasing equipment or beginning installation prior to obtaining approvals.

1.07 INFORMATION SUBMITTALS:

A. Contractor qualifications: The Fire Protection Subcontractor shall be a qualified fire protection contractor, licensed and regularly engaged in the installation of automatic fire sprinkler systems.
    1. Submit Fire Protection Subcontractor qualifications and license information.
    2. Submit proof of successful completion of three projects of similar size and scope.
B. Designer qualifications:
    1. Submit qualifications of Fire Protection Technician.
    2. Submit qualifications of Fire Protection Engineer.
C. Submit test certificates for flushing of underground prior to making connection to building sprinkler systems.

1.08 CLOSEOUT SUBMITTALS:

A. Submit Operation and Maintenance Data: Submit operations and maintenance manuals in accordance with DIVISION 01 "Contract Closeout". In addition to items specified in DIVISION 01, provide as-built drawings, material cut sheets, hydraulic calculations and one copy of NFPA 25.
    1. Include operation and maintenance data for valves and specialties in the operations and maintenance manuals.
B. Submit completed Contractor's Material and Test Certificate for Underground Piping in accordance with NFPA 24.
C. Submit completed Contractor's Material and Test Certificate for Aboveground Piping in accordance with NFPA 13.
D. Submit sprinkler zone diagram in accordance with Part 3 of this specification.

E. Submit documentation of training.
F. Submit complete warranty information.

1.09 QUALITY ASSURANCE:

A. Sprinkler systems shall be designed and installed in accordance with the applicable NFPA standards, locally adopted building code, fire code, and other local policies, interpretations and standards as listed in Part 1 References.
   1. If there is a conflict between the reference codes or standards and this SECTION, it is the Fire Protection Subcontractor's responsibility to notify the Engineer in writing. The most stringent requirement, as determined by the Engineer shall apply.
B. Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the annexes of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears.
C. The Fire Protection Subcontractor's responsibilities include designing, fabricating, and installing the sprinkler systems and providing professional design and engineering services needed to assume engineering responsibility.
D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.10 WARRANTY

A. Warrant all equipment and materials for a minimum of one-year from the date of substantial completion. The date of substantial completion will be signified by all test papers signed off by all necessary parties.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Unless otherwise noted, all materials shall be:
   1. Listed by Underwriter's Laboratories and included in the latest edition of the U.L. Fire Protection Equipment directory or Approved by FM Global and listed in the FM Global Approval Guide.
B. All sprinkler system components shall be rated for 175 psig minimum working pressure.

2.02 STEEL PIPE AND FITTINGS:

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
B. Schedule 40, Black Steel Pipe: ASTM A53, ASTM A795. Pipe ends may be factory or field formed to match joining method.
C. Schedule 40, Galvanized black Steel Pipe: ASTM A53, ASTM A795. Pipe ends may be factory or field formed to match joining method. All galvanized steel assemblies must be
D. Schedule 10, Black Steel Pipe: ASTM A135 or ASTM A795, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 12. Pipe ends may be factory or field formed to match joining method.
E. Malleable-Iron Unions: ASME B16.39.
F. Cast-Iron Flanges: ASME B16.1, 200 psig rated or Class 250, 500 psig rated. Fittings larger than NPS 12: Class 250, 300 psig rated.
G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

H. Steel Welded Fittings: ASTM A234 and ASME B16.9.
I. Stainless Steel Welded Fittings: ASTM A403 socket welded fittings.
J. Grooved-Couplings and Fittings:
   1. Factory Painted, Grooved-End Fittings for Steel Piping: ASTM A47, malleable-iron casting or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.
   2. Factory Painted Grooved-End-Pipe Couplings for Steel Piping: AWWA C606, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
   3. Couplings located outside including gaskets shall be listed for dry pipe service.
K. Provide shop welded piping, fittings, and flanges where welded connections are used.
L. Push on, plain end, "roust-a-bout" type and fittings using set screws are not acceptable.
M. Install fittings manufactured with outlets the same size as the piping to be installed in the fittings. Bushings are not acceptable.
N. Threaded pipe couplings with continuous threads through the coupling are not acceptable.
O. 1/2-inch extension couplings shall not be used at sprinkler connections.

2.03 PIPING JOINING MATERIALS:

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
D. Flexible couplings where required for seismic protection.

2.04 LISTED FIRE-PROTECTION VALVES:

A. Indicating Ball Valves:
   1. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. Valves NPS 3: Ductile-iron body with grooved ends.
   4. Required Options: Provide with visual indicating device and integral supervisory switch.
B. Bronze Check Valves:
   1. Sizes: NPS 1-1/2 and smaller.
   2. Standard: MSS SP-80
   3. Type: Swing check with renewable disc and seat.
   4. Body Material: Bronze.
   5. End Connections: Threaded.
C. Iron Check Valves:
   1. Type: Swing check with renewable disc and seat.
   2. Body Material: Cast iron or ductile iron.
   3. End Connections: Flanged or grooved.
   4. Required options:
      a. Tapped for automatic ball drip.
      b. Provide with removable inspection cover.
D. Butterfly valves
   1. See specification 211339.
E. OS&Y Valves
   1. See specification 211339.

2.05 TRIM AND DRAIN VALVES:

A. Angle Valves:
   1. Type: Screw in bonnet angle valve with integral seat and renewable disc.
   2. Body Material: Bronze or Brass.

B. Ball Valves:
   1. Type: Full port ball valve with blowout-proof stem.
   2. Body Material: Bronze or Brass.

C. Globe Valves:
   1. Type: Screw in bonnet globe valve with integral seat and renewable disc.
   2. Body Material: Bronze or Brass.

D. Automatic (Ball Drip) Drain Valves:
   1. Type: Automatic draining, ball check.
   2. Materials: Bronze body with stainless steel or brass ball check.
   3. End Connections: Threaded.

2.06 SPECIALTY VALVES:

A. General Requirements:
   1. Body Material: Cast or ductile iron unless noted otherwise.
   2. Size: Same as connected piping.

B. Alarm Valves:
   1. Design: For horizontal or vertical installation.
   2. Include trim set required for correct operation including bypass, drain, water flow alarm pressure switch, pressure gauges, and alarm line with strainer.
   3. End Connections: Flanged or Grooved.

C. Pressure Relief Valves:
   1. Type: Automatic resetting pressure relief valve
   2. Materials: Bronze body with stainless steel spring.
   3. Pressure setting: Factor set to relieve at 175 psi or 10 psi above maximum system pressure, whichever is less.
   4. End Connections: Threaded.

D. Pressure Regulating Valves:
   1. Type: Adjustable, globe pattern, pilot operated.
   2. Body Material: Ductile iron.
   3. Operation: Non-closing.

E. Inspector's Test Assemblies:
   1. Body Material: Brass or bronze housing with orifice, sight glass, integral test valve and pressure relief valve factory set to 175 psi.
   2. Size: Same as connected piping.
   3. Inlet and Outlet: Threaded.
   4. Individual components may be used in place of a listed assembly. This must include a test valve, sectional or main drain valve, sight glass, smooth bore corrosion-resistant orifice and pressure relief valve piped to drain.

2.07 FIRE-DEPARTMENT CONNECTIONS:

A. Exposed-Type, Fire-Department Connection:
   1. Type: Exposed, projecting, for wall mounting.
   2. Body Material: Corrosion-resistant metal.

3. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
4. Caps: Brass, lugged type, with gasket and chain.
5. Escutcheon Plate: Round, brass, wall type.
6. Outlet: With pipe threads.
7. Outlet Size: NPS 4
8. Number of Inlets: Two
9. Escutcheon Plate Marking: Similar to “AUTO SPKR & FOAM SYSTEM"
10. Finish: Rough chrome plated.

B. Yard-Type, Fire-Department Connection:
1. Type: Exposed, freestanding.
2. Body Material: Corrosion-resistant metal.
3. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
4. Caps: Brass, lugged type, with gasket and chain.
5. Escutcheon Plate: Round, brass, floor type.
6. Outlet: Bottom, with pipe threads.
7. Outlet Size: NPS 4.
8. Number of Inlets: Two
9. Sleeve: Not required.
10. Sleeve Height: 18 inches.
11. Escutcheon Plate Marking: Similar to “Foam System"
12. Finish Rough chrome

2.08 BACKFLOW PREVENTER:

A. Reduced Pressure Zone Assembly
1. Type: Reduced Pressure Zone
2. Operation: Continuous-pressure applications unless otherwise indicated.
3. Approval: FCCCHR listed, including vertically up vertically up (VUVU) installed orientation.
4. Body Material: Stainless steel or epoxy coated steel.
5. End Connections: Flanged.
6. Accessories:
a. OS&Y gate valves with flanged ends on inlet and outlet.
b. Bypass with displacement-type water meter measured in gpm, shutoff valves, and reduced-pressure backflow preventer.

2.09 TEST CONNECTION:

A. Exposed-Type, Outlet:
1. Type: Exposed, for wall mounting.
2. Body Material: Corrosion-resistant metal.
3. Outlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples and brass lugged swivel connections. Provide without drop clappers.
4. Caps: Brass, lugged type, with gasket and chain.
5. Escutcheon Plate: Rectangular, brass, wall type.
6. Outlet: With pipe threads.

7. Number of Outlets: Three.
8. Escutcheon Plate Marking: Similar to "PUMP, BACKFLOW, AND FOAM TEST HEADER"
9. Finish: Rough chrome plated.
10. Inlet Size: NPS 6

2.10 SPRINKLER SPECIALTY PIPE FITTINGS:

A. Mechanical tee and cross fittings are not acceptable.
B. Branch Outlet Fittings:
   1. Pressure Rating: 175 psig minimum
   2. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
   3. Type: Mechanical-tee and cross fittings.
   4. Configurations: Bolted split case body wrapping completely around the pipe. Saddle type fittings utilizing a single strap, snap-on, and strapless type fittings are not acceptable.
   5. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   6. Branch Outlets: Grooved or threaded.

2.11 SPRINKLERS:

A. General Requirements:
   1. Pressure Rating for standard Pressure Automatic Sprinklers
B. Standard Response Sprinklers:
   1. General Requirements:
      a. Temperature Rating: As indicated on the drawings or as required by NFPA 13.
      b. K factor: As indicated on the drawings or as required by the design.
   2. Standard Response Upright:
      a. Type: Standard response upright sprinkler.
      b. Finish: Rough brass finish in unfinished areas without suspended ceilings and beneath ductwork and ceiling mounted equipment.
C. Sprinkler cabinet per NFPA 13 with sprinklers and a wrench for each type of sprinkler.

2.12 ALARM AND SUPERVISORY DEVICES:

A. Alarm and supervisory device types shall match piping and equipment connections.
B. Water-Flow Alarm Horn/Strobe:
   1. Type: Electrically operated, 120V ac alarm horn/strobe.
C. Wet Pipe Sprinkler System Water-Flow Indicators:
   1. Water-Flow Detector: Electrically supervised.
   2. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with tamperproof cover.
   3. Option: Provide with contacts to send supervisory signal if cover is removed.
   4. Type: Pressure operated.
   5. Design Installation: Horizontal or vertical.
D. Valve Supervisory Switches:
   1. Type: Standard OS&Y type switch. Electrically supervised. Plug type switches are not allowed except where specifically indicated.
   2. Components: Single-pole, double-throw switch with normally closed contacts. Provide with tamperproof cover.
   3. Option: Provide with contacts to send supervisory signal if cover is removed.
   4. Design: Signals that controlled valve is in other than fully open position.

2.13 PRESSURE GAUGES:

A. Dial Size: 3-1/2- to 4-1/2-inch diameter.
B. Water Pressure Gauge Range: 0 to 300 psig with “Water” label on dial face.

2.14 AUTOMATIC AIR VENTS:

A. Type: Automatic air vent piped to exterior or interior drain in a visible location.
B. Options: Provide without electronic monitoring.
C. Alternate: Models with a secondary valve that automatically closes in case of air vent failure and with a visual indicator visible from the floor are acceptable and are not required to be piped to drain.

2.15 SUPPORTS, ANCHORS AND SEALS:

A. Hangers and Supports:
   1. Hangers and hanger assemblies shall be UL listed or FM Approved for use in fire protection systems.
   2. Hangers and supports shall be galvanized.
B. Seismic Design Components:
   1. Seismic design components and assemblies shall be UL listed or FM Approved for use in fire protection systems.
   2. Seismic design components other than piping shall be galvanized.
   3. Tension only bracing is not acceptable for bracing.
C. Pipe Stands:
   1. Type: Adjustable Pipe Saddle Support with U-bolt and Pipe Stanchion similar to Anvil Figure 265 Adjustable Pipe Saddle Support with U-bolt and Anvil Figure 63 Type T Pipe Stanchion.
   2. Stanchion diameter shall be per manufacturer’s published recommendations but not less than 2” diameter.
   3. Base plate size shall be per manufacturer’s published recommendations with holes for bolting to floor slab.
   4. Saddle shall include U-bolt or pipe clamp.
   5. Pipe stands and bases shall be galvanized.
D. Sleeves and Seals:
   1. Pipe sleeves through floor slabs, concrete, masonry or brick partition walls, fire barriers, fire walls and exterior building walls above and below grade shall be Schedule 40 black or galvanized steel pipe, fabricated of new material, cut square and reamed.
   2. Where piping passes through sleeves in floor slabs on grade or through building walls below grade, provide a modular mechanical seal, equal to Link-Seal, as manufactured by Pipeline Seal & Insulator, Inc.

2.16 PAINT AND PIPING IDENTIFICATION:

A. Paint
   1. Materials for painting of piping shall be in accordance with Division 09.
B. Piping Identification. Use one of the following:
   1. Equal to Seton Setmark snap-on pipe markers, red background with white letters. Snap-Around markers for pipe sizes 1 inch to 5-7/8 inch and Strap-Around for sizes 6 inch and larger.
   2. Equal to Seton Opti-Code self-adhesive pipe markers with arrows and pipe banding tape.

PART 3 - EXECUTION

3.01 DESIGN CRITERIA:

A. See 21 13 39 section 3.01.

3.02 SERVICE-ENTRANCE PIPING AND WATER-SUPPLY CONNECTIONS:

A. Connect sprinkler piping to water-service piping at the location 1 ft AG in the foam room.
B. Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-service piping.
C. Install shutoff valve, check valve, pressure gauge, and drain at connection to water service.
   1. The shutoff valves on either side of the backflow prevention device or check valve shall be OS&Y gate valves.
D. Install a listed strainer on the water service where indicated on the plans or where velocities in the underground piping exceed 8 feet per second.
E. Coordinate with underground utility and plumbing subcontractors for flushing of underground water service prior to connection to sprinkler system piping.
F. Do not connect the sprinkler system to the underground piping until the underground piping has been flushed and hydrostatically tested in accordance with NFPA 24. This includes the piping from 5 feet outside the building to the interior of the building. Submit test certificates to the Engineer prior to making connection.

3.03 PREPARATION OF PIPING:

A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.
B. Pipe shall be delivered with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

3.04 PIPING INSTALLATION:

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from Engineer.
B. Provide 3D fire protection coordination drawings for coordination with the other construction trades and participate in coordination meetings to insure all construction and building systems are coordinated. No change orders will be granted as a result of lack of coordination.
C. Coordinate fire protection installation with mechanical components including ductwork and piping, electrical systems and components, and all other building systems, as well as structural and architectural drawings.
D. Comply with requirements for installation of sprinkler piping in NFPA 13.
E. Install sprinkler piping with drains for complete system drainage.
F. Install chrome plated escutcheons on all exposed pipes passing through walls, floors, and ceilings.
G. Install automatic air vents at the high point of wet pipe sprinkler system to automatically vent air from the sprinkler system piping. Install a ball valve in the piping prior to each automatic air vent. Air vents with a visual indicator shall be installed such that they are visible from the floor. Vents and valves shall not be in installed above ceilings, ductwork, or other equipment.

H. Install a flanged connection, grooved connection or union on both sides of all equipment. Unions shall only be used on NPS 1 threaded piping.
I. Piping for wet pipe sprinkler systems shall be installed such that no piping traps air in excess of 5 gallons. Piping shall be installed such that air in piping will migrate to a single high point. An automatic air vent shall be installed at the high point.

3.05 PIPING SUPPORT:

A. Point loads on the building structure due to sprinkler piping may not exceed 300 lb. on any single structural member except where indicated otherwise on the drawings. This includes the weight of the water filled pipe only. The additional 250 lb. required by NFPA 13 is not required to be included in this maximum point load.
B. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
C. Pipe stands shall be securely fastened to the floor slab with 1/2 inch concrete anchors.
D. Threaded rod used to support piping shall not be formed or bent. Threaded rod shall not be used in the horizontal position to support vertical loading or as a pipe stand or column.
E. Sprinkler risers in stairs or other accessible locations shall be provided with supports to prevent lateral movement at the top and bottom of the riser.
F. Sprinkler piping and supports shall be designed in accordance with NFPA 13 requirements for *Protection of Piping Against Damage Where Subject to Earthquakes*.
G. Shear loads on the building structure due to sprinkler piping bracing may not exceed 500 lb. on any single structural member except where indicated otherwise on the drawings.

3.06 JOINT CONSTRUCTION:

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
B. Install a union adjacent to each valve in NPS 1 threaded piping. Install a grooved coupling or flange adjacent to each valve in threaded piping NPS 1-1/4 and larger.
C. Install flanges or grooved couplings on valves, apparatus, and equipment having grooved or flanged connections.
D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream pipe ends to remove burrs and restore full inside diameter prior to threading. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    3. When externally galvanized piping is threaded, coat exposed threads with a cold galvanizing, zinc coating.
F. Welded Joints: Construct joints according to NFPA 13, using qualified processes and welding operators that meet or exceed the requirements of AWS B2.1, *Specification for Welding Procedure and Performance Qualification*, and ASME *Boiler and Pressure Vessel Code*, Section IX, “Welding and Brazing Qualifications”.
    1. Shop weld pipe joints where welded piping is indicated.
    2. Do not use welded joints for galvanized-steel pipe.
G. Grooved joints:

1. All grooved couplings and fittings in a system shall be manufactured by the same manufacturer. Mixing of grooved couplings and fittings by different manufacturers or different designs of the same manufacturer is not acceptable.
2. Grooved couplings on mains shall be rigid type couplings except where flexible couplings are required by NFPA 13.
3. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints. Thin wall pipe shall not be cut grooved.
4. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Galvanized steel piping shall not be roll-grooved.

H. Washers are not required on listed assemblies such as grooved couplings except where washers are part of the listed assembly.

I. Minimize the number of joints and couplings by maximizing pipe lengths. Use of shortened pipe lengths to reduce the need for proper lifting and installation equipment is not acceptable.

3.07 PENETRATIONS, SLEEVES AND SEALS:

A. Openings for penetrations in walls and floors shall be made using a hole saw or core drill.
1. Sleeves are not required for core-drilled holes except where required by a UL through-penetration firestop system.
2. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
3. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
4. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
5. Using grout, seal the space outside of sleeves in slabs and walls.

B. Install modular mechanical seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
1. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.08 VALVE AND SPECIALTIES INSTALLATION:

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and Authorities Having Jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water supply connection. Install backflow preventers instead of check valves in potable water supply sources. Install pressure gauges on both sides of check valves and backflow preventers.
1. Install backflow preventers with bottom of the backflow preventer not more than 24 inches above finished floor.

2. Install backflow preventer test connections to allow forward flow testing of the backflow preventer at a flow rate equal to the highest sprinkler system demand.

D. Install pressure gauges on riser or feed main and at each sprinkler test connection. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.

E. Where the static pressure of the sprinkler system supply piping exceeds 175 psig, provide pressure regulating sprinkler control valve to reduce the pressure.
   1. Valves shall include “open-close” indicator and bracket for alarm supervisory switch.

F. Install a pressure relief valve in each wet pipe sprinkler system riser. Pipe discharge to drain.

G. Control and trim valves shall be installed in accessible locations not more than 7’-0” above finished floor.

H. Where drains discharge to a location other than the exterior of the building, the drain valve shall be located within sight of the drain piping discharge and provided with a splash block.

I. Do not locate auxiliary drains at or near the structure. Locate auxiliary drain valve at a location accessible from the floor. Pipe outlets to exterior at grade level or to hose connection 12 inches above finished floor. Plug outlets.

J. Provide a minimum of 3 feet of clearance in front of all equipment and 6 inches behind the equipment.

K. Normally closed valves required to be electronically supervised shall be butterfly valves designed and factory wired with a supervisory switch to supervise the valve in the closed position.

3.09 INSPECTOR’S TEST CONNECTION:

A. For each sprinkler system and for each waterflow alarm device, where multiple devices occur, furnish and install an inspector's test assembly. Pipe discharge from this assembly, to building exterior or as shown on drawings. Provide splash block at building exterior.

B. Furnish and install an inspector’s test connection on the remote branch line of each sprinkler system where required by the local Authority Having Jurisdiction.

3.10 SUPERVISORY SWITCHES, LOCKS AND SEALS:

A. Furnish and install a supervisory switch on each shutoff valve in the fire sprinkler and fire pump piping system to indicate when valve is not fully open. Adjust each supervisory switch to operate in accordance with NFPA 13 and NFPA 72.

B. In addition to the supervisory valve switches provided on each sprinkler system valve, the valves shall be locked or secured in the open position. All valve locks shall be keyed the same.

C. Normally closed OS&Y valve shall be supervised with plug type supervisory switches.

3.11 FLOW SWITCHES:

A. Furnish and install a flow switch for each system to monitor water flow in accordance with NFPA 72. Set retard on wet pipe sprinkler system flow switches to 60 seconds or as required by local Authorities Having Jurisdiction.

B. Flow switches installed in horizontal piping shall be installed on the top of the piping.

3.12 SPRINKLER INSTALLATION:

A. Sprinklers are to be located symmetrically with the column lines of the building.

B. Install sprinklers in accordance with NFPA 13 requirements regarding obstructions to sprinkler discharge.

C. Provide extra sprinklers of each style, enclosed in sprinkler cabinet, and one sprinkler wrench for each type. The number of extra sprinklers to be supplied is to be determined according to NFPA 13. Cabinet shall be mounted where directed by Owner.

3.13 FIRE-DEPARTMENT CONNECTION INSTALLATION:

A. Install exposed wall-type, fire-department connections.
B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in DIVISION 03.
   1. Install three protective pipe bollards around each end of fire-department connection grouping. Comply with requirements for bollards in Division 05.
C. Install check valve(s), located in a heated area, in the piping between the fire-department connection and sprinkler systems. Locate the check valve to maintain a minimum of 3'-0" of dry piping inside the building. Install check valve not more than 7'-0" above the finished floor to allow for inspection.
D. Install automatic (ball drip) drain valve at each check valve for fire-department connection to drain piping between fire-department connection and check valve. Pipe drain to floor drain or to outside building.
E. Piping between fire-department connections and check valves shall be galvanized.
F. Piping to the yard-type fire department connection shall be ductile iron. Install ball drip and drain field to drain the underground fire department connection piping. The drain field shall be composed of ¾" to 1½" washed rock fill (no fines). Provide drain field with a minimum of one-half cubic yard of rock from a minimum of 12-inches below the drain to a minimum of 6-inches above the drain and extending horizontally a minimum of 18-inches in both direction. Completely line the drain field with US 200 woven geotextile stabilization and separation fabric (or equivalent).

3.14 PAINTING AND IDENTIFICATION:

A. Install labeling and pipe markers on equipment and piping according to requirements in ASME A13.1, NFPA 13 and this section.
B. Preparation:
   1. Remove fabrication tags/labels and adhesives.
   2. Clean piping and equipment surfaces of substances that could impair bond of paint or identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
C. Label Installation:
   1. Provide permanent rigid plastic or metal NFPA 13 required signs on all control valves, drain valves, inspectors test valves, etc. Attach with jack chain.
   2. Install engraved rigid plastic or metal hydraulic information placards at each sprinkler system control valve. Hydraulic placards shall be engraved or filled out using another permanent method. Use of Dymo or Kroy tape, any type of pen or marker (including permanent marker), is not acceptable.
   3. Signs shall indicate each valve's normal position.
   4. Locate equipment labels where accessible and visible.
D. Pipe-Labels:
   1. Provide labeling and directional flow arrows on all mains. Provide white painted stenciled letters and arrows. Labels and flow arrows shall be a minimum of 2 inches in height and visible from at least two sides when viewed from the floor.
   2. Provide labels at the following locations:
      a. Near each valve.

b. Near penetrations through walls, floors, ceilings, and concealed spaces.
c. At access panels, doors, and similar access points that permit view of concealed piping.
d. Spaced at maximum intervals of 25 feet along each run.
e. Labels are not required on branch lines.
f. Labels shall be oriented such that they are readable from the floor.

3. Text on pipe labels shall be as follows:
a. Wet pipe sprinkler system piping: Fire Sprinkler
b. Fire Department Connection: Fire Department Connection

4. Self-adhesive labels shall be provided with pipe banding tape with directional arrows

E. Identify electrical system components, wiring, cabling, and terminals. Comply with requirements for identification specified in DIVISION 26 and DIVISION 28.

3.15 ELECTRICAL CONNECTIONS:

A. Wiring for sprinkler system supervision will be provided under DIVISION 26 and DIVISION 28. Coordinate location of these devices with the Fire Alarm and Electrical Subcontractors.

B. Furnish and install all electric wiring, conduit, accessory devices and make final control connections to maintenance air compressor as required, from the adjacent junction box provided under Division 26. All wiring shall be installed in compliance with Division 26 and NFPA 70.

3.16 FIELD QUALITY CONTROL:

A. Maintain a record set of drawings at the job site.

B. Participate in pre-testing between subcontractors to verify interface and function of all related building systems.

3.17 CLEANING:

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.18 TESTING:

A. An experienced representative of the Fire Protection Subcontractor shall perform all testing and inspections.
1. Perform tests required by NFPA 13 and 24.
2. Coordinate with underground utilities subcontractor for flushing of underground and water service mains in accordance with NFPA 13, "Systems Acceptance" Chapter and NFPA 24.
3. Pre-test all systems prior to request for witness by the Authority Having Jurisdiction and Engineer.
4. Hydrostatic testing shall include the piping between the fire department connection and the sprinkler systems.
5. Repair system and perform test or inspection again following failure of any test or inspection.
6. All tests shall be witnessed by the Authority Having Jurisdiction and Engineer.
7. Coordinate with fire alarm tests. Operate as required.
8. Coordinate with fire pump tests. Operate as required.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports. Submit test reports to Engineer. Provide copy of all test certificates in Owner's operation and maintenance manual.

1. Include NFPA 13, Contractor's Material and Test Certificate for Aboveground Piping.
2. Include NFPA 24 Contractor's Material and Test Certificate for Underground Piping.

3.19 DEMONSTRATION AND DOCUMENTATION:

A. Upon completion of the fire protection systems including testing, furnish the Owner a letter stating the sprinkler systems have been installed and tested in accordance with NFPA 13 and this specification. The letter shall be accompanied by the NFPA 24 Contractor's Material and Test Certificate for Underground Piping and the NFPA 13 Contractor's Material and Test Certificate for Aboveground Piping.
   1. This letter shall be signed and certified by the Fire Protection Technician responsible for design of the sprinkler system.

B. Operational Instruction: An experienced representative of the Fire Protection Subcontractor shall train the Owner's maintenance personnel to adjust, operate, and maintain the sprinkler systems.

C. Sprinkler Zone Diagram: At the completion of the sprinkler system installation, provide a small-scale plan of the building, color coded to define the limits of each sprinkler system and indicating the locations of all control valves, flow switches, low point drains, and inspector's test valves. The plan shall be neatly drawn, framed under clear plastic, and permanently mounted on a wall adjacent to the sprinkler control valve assembly. Provide one plan for each sprinkler system. A single plan may be used where multiple sprinkler system risers are located directly adjacent to one another.

D. Provide operations and maintenance manuals in accordance with DIVISIONS 01. Provide shop drawings, material cut-sheets, hydraulic calculations, and a copy of NFPA 25 in the sprinkler system operation and maintenance manuals.

3.20 PIPING SCHEDULE:

A. Use pipe types and joining methods complying with Part 2.

B. Standard or high-pressure, wet pipe sprinkler system piping shall be one of the following:
   1. Schedule 40, black-steel pipe with threaded ends; threaded fittings; and threaded joints.
   2. Schedule 40, black-steel pipe with cut-or roll-grooved ends; grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   3. Schedule 40, galvanized-steel pipe with cut-or roll-grooved ends; grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   5. Schedule 40, black-steel pipe with flanged ends; flanged fitting; and flanged joints.
   6. Schedule 10, black-steel pipe with roll-grooved ends; grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   7. Schedule 10, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   8. Schedule 10, black-steel pipe with flanged ends; flanged fitting; and flanged joints.

C. High pressure fittings and couplings shall be rated for a minimum of 300 psi.

D. Drain piping extending through the exterior wall shall be galvanized with galvanized fittings.

E. Fire department connection piping extending through the exterior wall shall be galvanized.

F. Piping between Fire-Department Connections and Check Valves: Galvanized, Schedule 40 steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

G. Piping upstream of the backflow preventer shall be galvanized or ductile iron complying with the requirements of the plumbing code.

3.21 SPRINKLER SCHEDULE:

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

END OF SECTION 211313

SECTION 211339 – LOW-EXPANSION FOAM SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Furnish all labor, materials, and equipment for fully operating fire protection systems in full compliance with the applicable NFPA standards and all other codes, regulations, and laws applicable to the work, and in full compliance with the intent of the plans and specifications, including all work inferable from same.

B. Section Includes:

1. Connect to flanged connection above grade as provided under DIVISION 33.
2. Solution piping, fittings, couplings, and specialties.
3. Concentrate piping and piping specialties.
4. Fire protection valves.
5. Piping supports, anchors, and seals.
6. Bladder tanks and proportioning devices.
7. Foam concentrate.
8. Discharge devices
9. Foam/ Water Hose Connections
10. Monitoring and Alarm devices.
11. Drain valves and piping.
12. System testing.

C. Pay for all necessary construction permits related to the foam suppression system.

D. Related Sections:

1. SECTION 21 13 13 – AUTOMATIC SPRINKLER SYSTEMS
2. SECTION 21 31 16 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS
3. SECTION 28 31 00 - FIRE ALARM SYSTEMS.
4. SECTION 33 12 16 – UNDERGROUND FIRE PROTECTION COMPONENTS

1.03 REFERENCES:

A. Applicable Codes and Standards (latest edition or as adopted by local jurisdiction):

1. 2022 Portland Specialty Structural code (PBC)
2. 2022 Portland Fire Code (PFC)
3. Local Codes including local policies, interpretation, and standards.
4. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI).
   a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
5. American Water Works Association (AWWA).
   a. AWWA C110 - Ductile-Iron and Gray-Iron Fittings for Water.
   b. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   c. AWWA C606 - Grooved and Shouldered Joints.
   d. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
   e. AWWA C153 - Ductile-Iron Compact Fittings for Water Service.
6. American Welding Society (AWS).
   a. AWS B2.1 - Specification for Welding Procedure and Performance Qualification.
   b. AWS D10.12 - Guide for Welding Mild Steel Pipe.
7. ASME International (ASME):

a. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications".
b. ASME A13.1 - Scheme for the Identification of Piping Systems.
c. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
d. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
e. ASME B16.3 - Malleable Iron Threaded Fittings.
f. ASME B16.4 - Gray Iron Threaded Fittings.
g. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Inch Standard.
h. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
i. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
j. ASME B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings.
k. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
l. ASME B31.9 - Building Services Piping.

8. ASTM International (ASTM).
   a. ASTM A47 - Specification for Ferritic Malleable Iron Castings.
   b. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. ASTM A312 - Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. ASTM A403 - Specification for Wrought Austenitic Stainless Steel Piping Fittings.
   e. ASTM A536 - Specification for Ductile Iron Castings.
   f. ASTM A795 - Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
   g. ASTM A865 - Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
9. FM Global (FM):
   a. FM Approvals - Approval Guide.
10. MSS (Manufacturer's Standardization Society) of the Valve and Fitting Industry, Inc.
    a. MSS SP-58 (2018) – Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
    b. MSS SP-80 (2019) - Bronze Gate, Globe, Angle, and Check Valves.
11. NFPA (National Fire Protection Association) - Latest edition or as adopted by local jurisdiction:
    a. NFPA 11 - Low-, Medium-, and High-Expansion Foam (2016)
    b. NFPA 13 – Standard for the Installation of Sprinkler Systems (2019).
    c. NFPA 20 – Standard for the Installation of Stationary Pumps for Fire Protection (2019).
    d. NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances (2020).
    e. NFPA 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (2017).
    f. NFPA 70 - National Electrical Code (2020).
    g. NFPA 72 – National Fire Alarm and Signaling Code (2019).
    h. NFPA 291 - Recommended Practice for Fire Flow Testing and Marking of Hydrants (2022).
    i. NFPA 1963 – Standard for Fire Hose Connections (2019).
12. Underwriters Laboratories Inc. (UL):
    a. Fire Protection Equipment Directory.

(1) UL 162 – Foam Equipment and Liquid Concentrates
(2) UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
(3) UL 405 – Fire Department Connection Devices.

1.04 DEFINITIONS:

A. References to the Fire Protection Engineer in this SECTION means:
B. References to the Fire Protection Technician in this SECTION means:
   1. A qualified fire protection technician certified at Level III or higher with the National Institute for Certification in Engineering Technologies (NICET) in Water Based Systems Layout.
C. References to the Authority Having Jurisdiction in this SECTION mean:
   1. The City of Portland Fire Marshal.
D. AFFF: Aqueous-Film Forming Foam
E. F3: Fluorine-Free Foam

1.05 SYSTEM DESCRIPTION:

A. Description: Engineered, fixed, manually actuated, low-expansion, F3 fire-extinguishing system for combustible-liquid fires. The system includes diaphragm proportioning tank, ratio controller, foam chambers, foam monitor, and other devices as described in NFPA 11.

1.06 PERFORMANCE REQUIREMENTS:

A. System design shall be approved by the Engineer and Authorities Having Jurisdiction (AHJ).
   1. See plans for system design criteria.
B. Seismic Performance: Suppression piping shall be designed to withstand the effects of earthquakes using the methods of NFPA 13, *Protection of Piping Against Damage Where Subject to Earthquakes*, and ASCE/SEI 7. Bracing design shall utilize the S_s value indicated on the structural plans and specifications.

1.07 ACTION SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.
B. Submit Shop Drawings: Include working plans, product data sheets, and hydraulic calculations. Prepare working plans, product data sheets, and hydraulic calculations for the complete suppression system in accordance with NFPA 13 and NFPA 11.
   1. Employ the services of a Fire Protection Engineer to prepare, sign, and seal the system shop drawings and hydraulic calculations for submittal.
   2. Employ the services of a Fire Protection Technician to prepare, sign and certify the system shop drawings and hydraulic calculations for submittal.
   3. The shop drawings, including resubmittals, shall be submitted as a complete submittal package including, but not limited to, shop drawings/working plans, annotated cut sheets, and hydraulic calculations. Partial submittals and submittals not fully complying with the requirements and recommended practices of NFPA 13 and NFPA 11 and this SECTION will be returned disapproved without review.
      a. At a minimum, the shop drawings shall include the following:
      b. Hydraulic Demand Design Calculations: Determine the minimum required flow and pressure at the pump for the pipe routing and size indicated for each tank. Additionally, provide hydraulic calculations for the flow and pressure demand at each FDC location for each system supplied from the location as though the system is individually supplied from the FDC.
      c. Plans: Show the following:

(1) Foam-solution proportioning tanks and devices, piping, discharge devices and accessories.
(2) Method of attaching hangers to building structure.
(3) Equipment and furnishings.

4. Shop drawing plans shall be drawn at a minimum scale of 1/8" = 1'-0".
5. Where the drawings or Part 3 of this specification indicate maximum loads on structural members, shop drawings shall include calculations to indicate maximum hanger loads. Detailed requirement shall be provided on the drawings to indicate maximum hanger spacing where maximum loads require hanger spacing less than maximums allowed by NFPA 13.
6. Product data sheets shall be included for all materials used. Product data sheets shall be annotated to indicate the exact model, size, finishes, and other options that will be provided. Data sheets with multiple models, options and sizes that are not annotated will not be accepted. Outdated or poorly reproduced cut sheets will not be accepted.
7. Include hydrant flow test information with shop drawing submittal.
8. The shop drawings shall include sway bracing calculations, locations of braces and flexible couplings, and clearance requirements.
9. Provide fire stopping details, with UL system numbers, for penetration through fire and smoke walls, barriers, and partitions.
10. Coordinate with other subcontractors to provide data sheets and details for items that may not be included in the Fire Protection Subcontractor's contract but are necessary for review of the shop drawings. This includes water service piping into the building, backflow preventers located outside the building, new underground piping, etc.
11. Shop drawings shall indicate the extent of the work area and shall indicate all work required as part of the contract.
12. Shop drawings shall be wholly generated and coordinated by the Fire Protection Subcontractor. Partial or complete reproductions of the Engineer's drawings will not be accepted.

C. Shop drawing resubmittals shall be accompanied by a response letter addressing each comment in the Engineer's review of the shop drawings. Changes to the working plans shall be clouded to indicate the revised area and annotated to indicate the revision number and revision date. Permit-Approved Drawings: Working plans prepared according to NFPA 11 and approved by authorities having jurisdiction.
D. Field quality-control reports.
E. Operation and Maintenance Data: For foam fire extinguishing to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, Section "Operation and Maintenance Data," include the following:
    a. Fire protection valves and valve specialties.
    b. Concentrate piping and piping specialties
    c. Piping supports, anchors, and seals.
    d. Bladder tanks and proportioning devices.
    e. Foam concentrate.
    f. Discharge devices.
    2. Submit shop drawings and hydraulic calculations to the City of Portland, OR for review.
    3. Submit shop drawings and hydraulic calculations to the Port of Portland for review.
    4. Submit shop drawings and hydraulic calculations as specified in DIVISION 01 SUBMITTALS to the Engineer for review.
F. Obtain all approvals prior to purchasing equipment or beginning installation.

G. The Fire Protection Subcontractor assumes sole responsibility for purchasing equipment or beginning installation before all approvals are obtained. No change orders will be awarded due to purchasing equipment or beginning installation prior to obtaining approvals.

1.08 INFORMATION SUBMITTALS:

A. Contractor qualifications: The Fire Protection Subcontractor shall be a qualified fire protection contractor, licensed and regularly engaged in the installation of a fire suppression systems of similar size and complexity.
   1. Submit Fire Protection Subcontractor qualifications and license information.
   2. Submit proof of successful completion of three projects of similar size and scope.

B. Designer qualifications:
   1. Submit qualifications of Fire Protection Technician.
   2. Submit qualifications of Fire Protection Engineer.

C. Submit test certificates for flushing of underground prior to making connection to aboveground systems.

1.09 CLOSEOUT SUBMITTALS:

A. Submit Operation and Maintenance Data: Submit operations and maintenance manuals in accordance with DIVISION 01 “Contract Closeout”. In addition to items specified in DIVISION 01, provide as-built drawings, material cut sheets, hydraulic calculations and one copy of NFPA 25.
   1. Include operation and maintenance data for valves and specialties in the operations and maintenance manuals.

B. Submit completed Contractor’s Material and Test Certificate for Underground Piping in accordance with NFPA 24.

C. Submit completed Contractor’s Material and Test Certificate for Aboveground Piping in accordance with NFPA 13.

D. Submit documentation of training.

E. Submit complete warranty information.

1.10 QUALITY ASSURANCE:

A. Suppression systems shall be designed and installed in accordance with the applicable NFPA standards, locally adopted building code, fire code, and other local policies, interpretations and standards as listed in Part 1 References.
   1. If there is a conflict between the reference codes or standards and this SECTION, it is the Fire Protection Subcontractor’s responsibility to notify the Engineer in writing. The most stringent requirement, as determined by the Engineer shall apply.

B. Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the annexes of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears.

C. The Fire Protection Subcontractor’s responsibilities include designing, fabricating, and installing the suppression systems and providing professional design and engineering services needed to assume engineering responsibility.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.11 WARRANTY

A. Warrant all equipment and materials for a minimum of one-year from the date of substantial completion. The date of substantial completion will be signified by all test papers signed off by all necessary parties.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Unless otherwise noted, all materials shall be:
   1. Listed by Underwriter's Laboratories and included in the latest edition of the U.L. Fire Protection Equipment directory or Approved by FM Global and listed in the FM Global Approval Guide.
   2. Listed by Underwriter's Laboratories and included in the latest edition of the U.L. Fire Protection Equipment directory.
   3. Approved by FM Global and listed in the FM Global Approval Guide.
      a. Where a product type is not available with FM Approval, a product Listed by Underwriter's Laboratories and included in the latest edition of the U.L. Fire Protection Equipment directory may be used where approved by the Engineer.

B. All system components shall be rated for 175 psig minimum working pressure.

2.02 FOAM SOLUTION STEEL PIPE AND FITTINGS:

A. Comply with requirements specified in this Section and Division 33, Section 33 12 16 for underground pipes, fittings, joining materials, and valves.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

C. Schedule 40, Galvanized Steel Pipe: ASTM A53, ASTM A795. Pipe ends may be factory or field formed to match joining method.

D. Galvanized and Uncoated, Malleable Iron Threaded Fittings: ASME B16.3, Class 150, 300 psig rated, standard pattern.

E. Malleable-Iron Unions: ASME B16.39.

F. Cast-Iron Flanges: ASME B16.1, Class 125, 200 psig rated or Class 250, 500 psig rated. Fittings larger than NPS 12Class 250, 300 psig rated.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

H. Grooved-Couplings and Fittings:
   1. Galvanized, Factory Painted, Grooved-End Fittings for Steel Piping: ASTM A47, malleable-iron casting or ASTM A536, ductile-iron casting; with dimensions matching steel pipe.
   2. Galvanized, Factory Painted Grooved-End-Pipe Couplings for Steel Piping: AWWA C606, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
   3. Gaskets for use on dry pipe systems shall be equal to Victaulic ‘Flush Seal’ UL listed for dry pipe service. Gaskets shall be lubricated in accordance with manufacturer's recommendations for dry pipe system gaskets.

I. Split flanges and flange adapters are not acceptable.

J. Install fittings manufactured with outlets the same size as the piping to be installed in the fittings. Bushings are not acceptable.

K. Threaded pipe couplings with continuous threads through the coupling are not acceptable.

2.03 FOAM SOLUTION PIPING JOINING MATERIALS:

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Flexible couplings where required for seismic protection capable of providing the lateral spread and vertical drop as indicated on the drawings. Design intent is for Metraflex Fire Loop or approved equal.

2.04 FIRE RATED FITTINGS

A. Listed rubber or other elastomeric-gasketed fittings shall be used in fire-exposed areas as indicated on the drawings. High-temperature-rated extra-heavy-duty grooved fittings, couplings, and gaskets shall be tested in accordance with API 607 and meet these criteria within industry standards in accordance with NFPA 11.

2.05 FOAM CONCENTRATE PIPING MATERIALS:

A. Stainless-Steel Pipe: ASTM A312, Schedule 40, Grade 304 or Grade 316, with factory-formed threaded or beveled ends; ASTM A376 for seamless pipe; or ASTM A213, ASTM A249, and ASTM A269 for seamless and welded tubing.
   1. Butt-Weld Fittings: ASTM A403.
   2. Flanges, Forged Fittings and Flanges, and Socket-Weld Fittings: ASTM A182.

B. Red Brass Pipe: ASTM B43, Schedule 40, with factory- or field-formed threaded ends.

2.06 LISTED FIRE-PROTECTION VALVES:

A. Indicating Ball Valves:
   1. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. Valves NPS 3: Ductile-iron body with grooved ends.
   4. Required Options: Provide with visual indicating device and integral supervisory switch.

B. Bronze Check Valves:
   1. Sizes: NPS 1-1/2 and smaller.
   2. Standard: MSS SP-80
   3. Type: Swing check with renewable disc and seat.
   4. Body Material: Bronze.
   5. End Connections: Threaded.

C. Iron Check Valves:
   1. Type: Swing check with renewable disc and seat.
   2. Body Material: Cast iron or ductile iron.
   3. End Connections: Flanged or grooved.
   4. Required options:
      a. Tapped for automatic ball drip.
      b. Provide with removable inspection cover.

D. Bronze OS&Y Gate Valves:
   1. Sizes: NPS 2 and smaller.
   2. Body Material: Bronze.

3. End Connections: Threaded.

E. Iron OS&Y Gate Valves:
1. Pressure Rating: 250 psig minimum.
2. Type: Resilient wedge OS&Y gate valve.
3. Body Material: Cast or ductile iron. Fusion bonded epoxy coating inside and out.
4. Wedge material: EPDM encapsulated cast or ductile iron.
5. End Connections: Flanged or grooved.
6. Accessories: Pre-grooved stem for mounting tamper switch.

F. Indicating-Type Butterfly Valves:
1. Valve Type: Butterfly.
2. Body Material: Epoxy coated ductile iron.
3. Disc material: EPDM encapsulated ductile iron.
4. End Connections: Flanged or grooved.
5. Required options: Provide with visual indicating device and integral supervisory switch with two single-pole, double-throw circuits.

2.07 TRIM AND DRAIN VALVES:

A. Ball Valves:
1. Type: Full port ball valve with blowout-proof stem.
2. Body Material: Bronze or Brass.

2.08 FIRE DEPARTMENT CONNECTIONS

A. See Specification 211313.

2.09 SPECIALTY VALVES:

A. General Requirements:
1. Body Material: Cast or ductile iron unless noted otherwise.
2. Size: Same as connected piping.

B. Ball Drain Valves:
1. Type: draining, ball check.
2. Materials: Bronze body with stainless steel or brass ball check.
3. End Connections: Threaded.

C. Concentrate Control Valves:
1. Water-operated ball or deluge valve designed to open with flow through the proportioning controller.

2.10 FOAM CONCENTRATE

A. Fluorine Free Foam concentrate, complying with NFPA 11 and UL 162 and listed with all relevant components, for making foam-water fire-extinguishing foam solution. Provide 3% foam concentrate. Where possible, MILSPEC foam shall be provided.

2.11 FOAM CONCENTRATE SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Perimeter Solutions, LP
2. National Foam, part of the Kidde Fire Fighting Organization
3. Approved Equals

B. Systems shall comply with NFPA 11, be compatible and listed with the foam concentrate, proportioner, and discharge devices and be designed to be drained and cleaned.

C. Foam Concentrate Storage Tanks
   1. Buna-N, bladder-type proportioning tank complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII; designed for use with foam-concentrate proportioner and for specific type of foam concentrate used. Include bladder, internal piping, fill and drain, glass sight gauge, piping, and valves. Contain foam concentrate in the bladder.
      a. Orientation: Horizontal design with saddle support.
      b. Sizing: Determined by subcontractor via hydraulic calculation for worst case.

D. Proportioning Controllers:
   1. Venturi type Complying with UL 162 and of capacity to match design at minimum and maximum flow.

2.12 TEST CONNECTION:

A. See Specification 211313.

2.13 DISCHARGE DEVICES

A. Discharge devices shall be UL listed or FM Approved to be used with provided foam concentrate.

B. Foam chambers
   1. Foam chamber Type II or approved equal with frangible seals as required per NFPA 11.
      a. Refer to drawings for requirements.

C. Foam Monitors:
   1. Material:
      a. Cast Brass.
      b. Aluminum.
      c. Stainless Steel.
      d. Approved Equal.
   2. Minimum 3-inch waterway with 1250 gpm rated flow.
   3. Operator
      a. Manual:
         (1) Local:
         (2) Tiller Bar.
         (3) Single Handwheel.
         (4) Dual Handwheel.
      b. Inlet:
         (1) Minimum 4-inch. (3-inch) ASME B16.1 Class 125 flat-face flange.
      c. Outlet:
         (1) Minimum 2½-inch male NHT.
      d. Oil-filled pressure gauge port at discharge.
      e. With(out) intrinsic quarter-turn valve.
      f. Manual locks on loft and rotation.
   4. Oscillating:
      a. 4-inch ASME B16.5 Class 150 flat-face flanged water-operated oscillating flange.
      b. Maximum 2 gpm water discharge necessary for oscillation.
      c. Capable of manual override.
      d. Maximum flow: 1250 gpm.
      e. Maximum operating pressure: 250 psig.
      f. Minimum operating pressure: 50 psig.
      g. Speed-adjustable for 0 – 30°/second.

h. Maximum angle of oscillation: 165°.
i. Minimum oscillating increments: 6.
j. Approved models:
(1) Akron Brass Style 3531.
(2) Ansul Model WOM-4.
(3) Chemguard CWPOM/EF10155.
(4) Elkhart Brass Style WPO-2000.
(5) National Foam HOM-2B.
(6) Potter Roemer/Fire Pro Oscillating Monitors.
(7) Task Force Tips Flanged Oscillating Monitor.
(8) Williams WPOM.
(9) Approved Equal.

5. Coating:
a. Internal and external surfaces of monitor shall be factory-electrostatically coated with fusion bonded epoxy with a fire-engine red (orange) finish.

6. Monitor Nozzle:
a. Acceptable Manufacturers:
(1) Akron Brass.
(2) Elkhart Brass.
(3) Task Force tips.
(4) Stang Industrial.
(5) Williams Fire.
(6) Approved equal.
b. Type: Masterstream.
(1) Flow capable of 500 gpm at 80 psig.
c. Inlet:
(1) 2 ½" Female NHT with collar.
d. Features:
(1) Nozzle shall not have twist shutoff capabilities.
(2) Nozzle may be locked in narrow-fog pattern.
(3) Nozzle may flow either firewater or foam solution but will flow foam in this system.
e. Material: Brass.

2.14 MANIFOLDS

A. Valve Manifold
1. Fabricate manifold as described in the Contract Documents.

2.15 FIRE-DEPARTMENT CONNECTIONS:

A. Exposed-Type, Fire-Department Connection:
1. Type: Exposed, for wall mounting.
2. Body Material: Corrosion-resistant metal.
3. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
4. Caps: Brass, lugged type, with gasket and chain.
5. Escutcheon Plate: Rectangular, brass, wall type.
6. Outlet: With pipe threads.
7. Outlet Size: NPS 4

8. Number of Inlets: Two.
9. Escutcheon Plate Marking: Similar to "FIRE WATER CONNECTION" or "FOAM SOLUTION CONNECTION"
10. Finish: Rough chrome plated.

2.16 STRAINER:

A. Foam Concentrate Strainers:
   1. Bronze body and stainless-steel mesh strainer with maximum 0.125-inch perforations to remove solids that would block system components.

2.17 BACKFLOW PREVENTER:

A. See specification 211313.

2.18 PIPE FITTINGS:

A. Mechanical tee and cross fittings are not acceptable.

2.19 ALARM AND SUPERVISORY DEVICES:

A. Alarm and supervisory device types shall match piping and equipment connections.
B. Water-Flow Indicators:
   1. Water-Flow Detector: Electrically supervised.
   2. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard from 0-90 seconds to prevent false signals and tamperproof cover.
   3. Option: Provide with contacts to send supervisory signal if cover is removed.
   4. Type: Paddle operated.
   5. hDesign Installation: Horizontal or vertical.
C. Valve Supervisory Switches:
   1. Type: Standard OS&Y type switch. Electrically supervised. Plug type switches are not allowed except where specifically indicated.
   2. Components: Single-pole, double-throw switch with normally closed contacts. Provide with tamperproof cover.
   3. Option: Provide with contacts to send supervisory signal if cover is removed.
   4. Design: Signals that controlled valve is in other than fully open position.

2.20 PRESSURE GAUGES:

A. Dial Size: 3-1/2- to 4-1/2-inch diameter.
B. Water Pressure Gauge Range: 0 to 300 psig with “Water” label on dial face.
C. Air Pressure Gauge Range: 0 to 80 psig retard to 250 psig with “Air” label on dial face.
D. Foam system Pressure Gauges: Comply with UL 393; with 3-1/2-inch minimum-diameter dial, 0- to 300-psig dial range, and caption "WATER" or "CONCENTRATE" on dial face.

2.21 SUPPORTS, ANCHORS AND SEALS:

A. Hangers and Supports:
   1. Hangers and hanger assemblies shall be UL listed or FM Approved for use in fire protection systems.
   2. Hangers and supports shall be galvanized.
B. Seismic Design Components:
   1. Seismic design components and assemblies shall be UL listed or FM Approved for use in fire protection systems.

2. Seismic design components other than piping shall be galvanized.
3. Tension only bracing is not acceptable.
4. Tension only bracing shall not be painted.

C. Pipe Stands:
1. Type: Adjustable Pipe Saddle Support with U-bolt and Pipe Stanchion similar to Anvil Figure 265 Adjustable Pipe Saddle Support with U-bolt and Anvil Figure 63 Type T Pipe Stanchion.
2. Stanchion diameter shall be per manufacturer's published recommendations but not less than 2" diameter.
3. Base plate size shall be per manufacturer's published recommendations with holes for bolting to floor slab.
4. Saddle shall include U-bolt or pipe clamp.
5. Pipe stands and bases shall be galvanized.

D. Sleeves and Seals:
1. Pipe sleeves through floor slabs, concrete, masonry or brick partition walls, fire barriers, fire walls and exterior building walls above and below grade shall be Schedule 40 black or galvanized steel pipe, fabricated of new material, cut square and reamed.
2. Where piping passes through sleeves in floor slabs on grade or through building walls below grade, provide a modular mechanical seal, equal to Link-Seal, as manufactured by Pipeline Seal & Insulator, Inc.

2.22 PAINT AND PIPING IDENTIFICATION:

A. Paint
1. Materials for painting of piping shall be in accordance with Division 33.
2. Paint all fire foam pipe within the dike area red.

B. Piping Identification. Use one of the following:
1. Equal to Seton Setmark snap-on pipe markers, red background with white letters. Snap-Around markers for pipe sizes 1 inch to 5-7/8 inch and Strap-Around for sizes 6 inch and larger.
2. Equal to Seton Opti-Code self-adhesive pipe markers with arrows and pipe banding tape.

2.23 SIGNAGE

A. General: Signage shall be provided as indicated on drawings.

B. An updated color coded "map" of the sited fire protection system, including fuel storage tanks, fuel equipment pads, monitors, foam chambers, manifold, fire protection valves and piping, shall be provided and installed at the foam building and at fire department connections 1 and 2. The "map" shall be a minimum 30" high by 42" wide minimum size, of construction as described below. A rendition of the "map" shall be submitted for Contractor and Fire Department approval.

C. Map shall mimic the overall one-line of the site's fire suppression system for fire department use.

D. Signage and map construction:
1. Reinforced fiberglass, ¼-inch thickness, specifically designed for exterior use. Panels shall be double-faced with legend on one face.
2. For fire protection system "map", copy shall be applied by screen printing process over color-coated fiberglass with polyurethane finish.
3. Site fire protection signage shall be engraved into 3-ply laminate construction exposing contrasting color core. 1-inch high lettering on plate of height and length as required.
4. Colors to be selected from manufacturer's standards and submitted for approval.

5. Support and Framing System:
   a. Two or three-inch square extruded aluminum with concealed panel fastening system, post caps. Suitable anchoring plates and concrete bases shall be provided.
   b. Framing and sign to withstand wind conditions normal to the locality.
6. Locations shall be as indicated.

PART 3 - EXECUTION

3.01 DESIGN CRITERIA:

A. Design and hydraulically calculate the piping systems including the locations of all valves, devices, discharge devices. Design systems based on the hazard protected as determined by the most stringent requirements of State and Local Building and Fire Codes, NFPA 11, and the Contract Documents. In addition to all hydraulic demand design calculations for the pump system, hydraulic demand design calculations shall be determined for each of the remote FDCs for each of the four systems as though the complete system demand is coming from the respective FDC (8 calculations) and shall determine the minimum required flow and pressure at FDC for the pipe routing and size indicated for each system. This information shall be indicated on the respective signage to be provided

B. Systems shown on the drawings are based on hydraulic design method. Fire Protection Subcontractor may redesign the piping system to coordinate with other mechanical and electrical ductwork and piping systems and the structural constraints of the building. Pipe sizes shown on the drawings are minimums and may be upsized where indicated by the Fire Protection Subcontractor's hydraulic calculations. Design of system shall be based on the hazard protected as determined by the most stringent requirements of State and Local Building and Fire Codes, NFPA 11, the Owner's Insurance Underwriter, and the Contract Documents.

C. Water supply flow test information on the plans is for bid purposes only. Perform a new water flow test at the location of the building to verify the available water supply prior to design and installation of the system. Perform the flow test in accordance with NFPA 291 and NFPA 13. Submit new hydrant flow test with shop drawings. Flow test information shall include date, time, witness, location of flow and pressure hydrant, static and residual pressures, pitot pressures, hydrant coefficients, residual flow rates and hydrant elevations relative to the building floor. Include a site plan with water main locations, static and residual hydrant location, and hydrant and ground floor building elevations.

3.02 DEMOLISHED PIPING

A. Piping shall be demolished as shown on the drawings. Phasing prior to project completion shall be coordinated to minimize or eliminate periods of inoperability of the fire suppression system in functional and operating storage tanks and other areas of the facility whether existing or new.

3.03 SERVICE-ENTRANCE PIPING AND WATER-SUPPLY CONNECTIONS:

A. See Specification Section 211313.

3.04 PREPARATION OF PIPING:

A. Ream pipe ends to remove burrs. Make joints smooth and unobstructed inside. Remove any obstructions or debris inside piping, blowing it out with compressed air or otherwise cleaning it internally immediately prior to assembly.

B. Pipe shall be delivered with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

3.05 PIPING INSTALLATION:

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from Engineer.

B. Pitch above grade foam solution piping in accordance with NFPA 13 requirements for dry pipe systems including auxiliary drains where needed.

C. Provide 3D fire protection coordination drawings for coordination with the other construction trades and participate in coordination meetings to ensure all construction and building systems are coordinated. No change orders will be granted as a result of lack of coordination.

D. Coordinate fire protection installation with mechanical components including ductwork and piping, electrical systems and components, and all other building systems, as well as structural and architectural drawings.

E. Comply with requirements for installation of piping in NFPA 11.

F. Install foam system piping with drains for complete system drainage.

G. Install chrome plated escutcheons on all exposed pipes passing through walls, floors and ceilings inside buildings.

H. Install a flanged connection, grooved connection or union on both sides of all equipment. Unions shall only be used on NPS 1 threaded piping.

I. All foam system piping downstream of the manual system valves in the foam/pump room shall be normally empty with means to fully drain each piping section after activation.

3.06 PIPING SUPPORT:

A. Point loads on the building structure due to system piping may not exceed 300 lb. on any single structural member except where indicated otherwise on the drawings. This includes the weight of the water filled pipe only. The additional 250 lb. required by NFPA 13 is not required to be included in this maximum point load.

B. Install hangers and supports for system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

C. Pipe stands shall be securely fastened to the floor slab with 1/2 inch concrete anchors.

D. Threaded rod used to support piping shall not be formed or bent. Threaded rod shall not be used in the horizontal position to support vertical loading or as a pipe stand or column.

E. Risers in other accessible locations shall be provided with supports to prevent lateral movement at the top and bottom of the riser.

F. Suppression piping and supports shall be designed in accordance with NFPA 13 requirements for *Protection of Piping Against Damage Where Subject to Earthquakes*.

G. Shear loads on the structure due to piping bracing may not exceed 500 lb. on any single structural member except where indicated otherwise on the drawings.

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

3.07 JOINT CONSTRUCTION:

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install a union adjacent to each valve in NPS 1 threaded piping. Install a grooved coupling or flange adjacent to each valve in threaded piping NPS 1-1/4 and larger.

C. Install flanges or grooved couplings on valves, apparatus, and equipment having grooved or flanged connections.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream pipe ends to remove burrs and restore full inside diameter prior to threading. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   3. Do not thread externally galvanized piping.

F. Welded Joints:
   1. Do not use welded joints for galvanized-steel pipe.

G. Grooved joints:
   1. All grooved couplings and fittings in a system shall be manufactured by the same manufacturer. Mixing of grooved couplings and fittings by different manufacturers or different designs of the same manufacturer is not acceptable.
   2. Grooved couplings on mains shall be rigid type couplings except where flexible couplings are required by NFPA 13.
   3. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

H. Washers are not required on listed assemblies such as grooved couplings except where washers are part of the listed assembly.

A. Minimize the number of joints and couplings by maximizing pipe lengths. Use of shortened pipe lengths to reduce the need for proper lifting and installation equipment is not acceptable.

3.08 PENETRATIONS, SLEEVES AND SEALS:

A. Openings for penetrations in walls and floors shall be made using a hole saw or core drill.

B. Install sleeves for piping passing through penetrations in all walls and floors.
   1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
   2. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   3. Using grout, seal the space outside of sleeves in slabs and walls.

C. Install modular mechanical seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
   1. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.09 CONCENTRATE STORAGE TANK INSTALLATION:

A. Equipment Mounting: Install concentrate storage tanks on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in DIVISION 03.
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct bases to withstand, without damage to equipment, seismic force required by code.
   3. Construct concrete bases 4 inches high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of concentrate storage tank unless otherwise indicated or unless required for seismic anchor support.
   4. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
   5. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
   6. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
   7. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   8. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install concentrate storage tanks anchored to substrate according to tank manufacturer's written instructions.

C. Install tanks level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

D. Install seismic restraints for tanks. Anchor tanks to substrate.

E. Coordinate access with Ops building architect to both ends of the tank allowing for access to replace the tank bladder.

3.10 FOAM CHAMBER INSTALLATION:

A. Coordinate location of foam chambers with the mechanical plans, other equipment, and piping.

B. Install foam chambers in accordance with the manufacturer’s requirements and recommendations.

3.11 MANIFOLD AND MONITOR INSTALLATION:

A. Install manifolds mounted with pumper connections facing the adjacent roadway and post indicator valve close to its controlling apparatus but with sufficient space to operate upstream gate valve.

B. Install plumb, vertical and level.

C. Swiveling manifolds shall be able to rotate 360° without interference.

D. Provide 24”x24”x6” precast concrete slab against undisturbed soil at the base elbow of manifolds.

E. Install monitor and associated equipment as indicated per Contract Documents.
   1. Where monitor is standalone, no intrinsic-valve shall be provided.

F. Monitors shall be left in service such that foam liquid is not trapped aboveground in any upstream piping or in the monitor curvature.

3.12 VALVE AND SPECIALTIES INSTALLATION:

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 11, NFPA 13, and Authorities Having Jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Install check valves in piping as shown on drawings to minimize fill volumes required before discharge devices will discharge as designed.
D. Install pressure gauges on riser for test connection. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal and install where they will not be subject to freezing.
E. Control and trim valves shall be installed in accessible locations not more than 7’-0” above finished floor.
F. Where auxiliary drains discharge to a location other than the exterior of the building, the drain valve shall be located within sight of the drain piping discharge.
G. Restrain grooved OS&Y gate valves installed in horizontal piping to prevent valve from rotating due to weight of the valve stem.

3.13 CHARGING SYSTEM:

A. Fill proportioning tanks with foam concentrate after field quality-control testing is complete and satisfactory results have been achieved.

3.14 SUPERVISORY SWITCHES, LOCKS AND SEALS:

A. The foam solution control valves shall be locked or secured in the closed position. All valve locks shall be keyed the same.
B. Post indicator valves shall be supervised electrically and provided with a lock.
C. Normally closed OS&Y valve shall be supervised with plug type supervisory switches.
D. Provide seals on all trim valves that would adversely affect the operation of the systems or cause or prevent activation of alarm signals.

3.15 PAINTING AND IDENTIFICATION:

A. Install labeling and pipe markers on equipment and piping according to requirements in ASME A13.1, NFPA 13, NFPA 11 and this section.
B. Preparation:
    1. Remove fabrication tags/labels and adhesives.
    2. Clean piping and equipment surfaces of substances that could impair bond of paint or identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
C. Label Installation:
    1. Provide permanent rigid plastic or metal NFPA 13 required signs on all control valves, drain valves, etc. Attach with jack chain.
    2. Install engraved rigid plastic or metal hydraulic information placards at each system control valve. Hydraulic placards shall be engraved or filled out using another permanent method. Use of Dymo or Kroy tape, any type of pen or marker (including permanent marker), is not acceptable.
    3. Signs shall indicate each valve’s normal position.
    4. Locate equipment labels where accessible and visible.
D. Piping Color-Coding:
    1. Paint all exposed suppression system piping red.
    2. Methods and materials shall comply with specification 33 52 46 .
E. Pipe-Labels:

1. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations.
2. Provide labels at the following locations:
   a. Near each valve, pump or specialty.
   b. Near penetrations through walls and floors.
   c. Spaced at maximum intervals of 25 feet along each run.
   d. Labels shall be oriented such that they are readable from the floor.
3. Text on pipe labels shall be as follows:
   a. Fire Department Connection: Fire Department Connection
   b. Piping downstream of the proportioner: Foam Solution
   c. Piping upstream of the proportioner: Fire water
   d. Foam Concentrate Piping: Concentrate
4. Self-adhesive labels shall be provided with pipe banding tape with directional arrows wrapped entirely around the pipe at each side of label.

3.16 FIELD QUALITY CONTROL:

A. Maintain a record set of drawings at the job site.

B. Participate in pre-testing between subcontractors to verify interface and function of all related building systems.

C. Inspection: Engage the services of a fire protection specialist to inspect installed fire-extinguishing systems, prepare installation report, and certify that installation complies with the Contract Documents, calculations, and requirements of authorities having jurisdiction.

D. Comply with operating instructions and procedures in NFPA 11, "Acceptance Tests" Chapter. Include the following tests and inspections to demonstrate compliance with requirements:
   1. Check mechanical items.
   2. Inspect equipment and check mountings for adequate anchoring to substrate.
   3. Check electrical systems.
   4. Flush supply piping.
   5. Perform hydrostatic pressure test.
   6. Perform acceptance test.
   7. Perform proportioning system test.
   8. Perform discharge test.
   9. Flush underground system piping.
   10. Correct malfunctioning equipment; retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or does not perform as specified and indicated; retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
   11. Capture all testing materials in accordance with local environmental jurisdiction.

E. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations including connections, and to assist in testing.

3.17 CLEANING:

A. Clean dirt and debris from end devices.

3.18 TESTING:

A. Prior to any testing is performed a system testing plan must be submitted to the Engineer for review. As a part of this plan, a capture and disposal plan shall be submitted to the Engineer and the Owner for review.

B. An experienced representative of the Fire Protection Subcontractor shall perform all testing and inspections.
   1. Perform tests required by NFPA 11 and NFPA 13 and as specified in this SECTION. Submit test reports to Contractor. Provide copy of all test certificates and reports in Owner's operation and maintenance manual.
   2. Coordinate with underground utilities subcontractor for flushing of underground and water service mains in accordance with NFPA 13, "Systems Acceptance" Chapter and NFPA 24.
   3. Pre-test all systems prior to request for witness by the Authority Having Jurisdiction and Engineer.
   4. Hydrostatic testing shall include the piping between the fire department connection and the suppression systems.
   5. Repair system and perform test or inspection again following failure of any test or inspection.
   6. All tests shall be witnessed by the Authority Having Jurisdiction and Engineer.
   7. Coordinate with fire alarm tests. Operate as required.
   8. Coordinate with fire pump tests. Operate as required.

C. Piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports. Submit test reports to Engineer. Provide copy of all test certificates in Owner's operation and maintenance manual.
   1. Include NFPA 13, Contractor's Material and Test Certificate for Aboveground Piping.
   2. Include NFPA 24 Contractor's Material and Test Certificate for Underground Piping.

E. Foam/Water Discharge Testing Plan
   1. Provide a testing plan certified by the Fire Protection Specialist that includes the following:
      a. Who will perform the testing and who will be the onsite factory authorized representatives?
      b. What are the safety precautions taken during testing?
      c. How will the foam/water system be tested to demonstrate the performance criteria has been met? E.g.
         (1) Foam: Turn normally open valves around bladder tank to closed. Ensure foam will flow into safe, contained area such as a banker tank, that will not cause any environmental damage. Open fire water valve in foam house. Let water flow. Test the water flow through each test head. Record pressures at each test head for review. Once flow is proven, prepare foam collection materials. Use the testing valve to collect 3 foam samples every 15 seconds after the concentrate valves are opened. After the samples are taken, close concentrate valves and fire water valve. Record the samples and foam test completion for review. This should fulfill: Foam concentrate test, foam test, and flow test.
         (2) Full system operational test:
            (a) Foam Chambers
            (b) Foam / Water Monitors
      d. How will the foam testing effluent be captured during the testing period?
      e. How will the event be recorded for future review?

f. What are the testing procedures to demonstrate the coordination and communication of the fire protection systems associated with the foam/water discharge?
g. Test with a surrogate foam where permitted by the AHJ. Provide modification to the foam induction system to permit testing with a surrogate foam when permitted.

F. Subcontractor shall notify the Contractor and Owner at least ten days prior to testing. All tests shall be witnessed and signed off by the Owner, Contractor, AHJ's, and insurance carrier.
G. Coordinate testing of systems and provide all personnel required to demonstrate the system functionality and communication through full functional testing. Independent testing of each individual fire protection system is not a substitute to the functional testing requirements.
H. The Subcontractor shall provide all materials, equipment and personnel required to test the systems as specified. This includes foam concentrate, play pipes, meters, gauges, and other devices required for complete system testing, preparation, testing, measurement, clean-up, disposal, refilling and preparing to put into service.
I. Upon completion of testing, subcontractor shall flush all areas exposed to foam/water not normally charged with foam/water with potable water and shall remove and dispose of all protection materials.
J. Post-discharge test requirements: Following the successful completion of the tests, the subcontractor shall remove the foam solution from the site as indicated on the approved foam waste containment and disposal plan. Subcontractor shall replenish foam concentrate consumed during the tests. Discharged solution shall be contained and disposed of in a manner acceptable to local authorities and identified on the approved test plan. Once tests are completed, systems shall be returned to fully operational status, including filling of AFFF concentrate tanks with concentrate.
K. The Subcontractor shall clean and restore all systems to normal conditions after completion of tests. The Subcontractor shall repair or replace all materials and components damaged as a result of testing at no additional cost to Owner or General Contractor.
L. The Fire Protection Specialist shall witness testing and review test reports as outlined in this section.
M. Prepare final test and inspection reports.
1. Include NFPA 11 Contractor's Material and Test Certificate for Low-, Medium-, and High-Expansion Foam Systems for each system.
2. Include NFPA 13 and 24, Contractor's Material and Test Certificate for Above and Underground Piping.

3.19 DEMONSTRATION AND DOCUMENTATION:

A. Upon completion of the fire protection systems including testing, furnish the Owner a letter stating fire suppression systems have been installed and tested in accordance with NFPA 11 and NFPA 13 hand this specification. The letter shall be accompanied by the NFPA 24 Contractor's Material and Test Certificate for Underground Piping and the NFPA 13 Contractor's Material and Test Certificate for Aboveground Piping.
1. This letter shall be signed and certified by the Fire Protection Technician responsible for design of the system.
B. Operational Instruction: An experienced representative of the Fire Protection Subcontractor shall train the Owner's maintenance personnel to adjust, operate, and maintain the suppression systems.
C. Zone Diagram: At the completion of the foam system installation, provide a small-scale plan of the area, color coded to define the limits of each suppression system and indicating the

locations of all control valves, flow switches, and low point drains. The plan shall be neatly drawn, framed under clear plastic, and permanently mounted on a wall adjacent to the control valve assembly. Provide one plan for each system. A single plan may be used where multiple system risers are located directly adjacent to one another.

D. Provide operations and maintenance manuals in accordance with DIVISIONS 01. Provide shop drawings, material cut-sheets, hydraulic calculations, and a copy of NFPA 25 in the system operation and maintenance manuals.

3.20 PIPING SCHEDULE:

A. Use pipe types and joining methods complying with Part 2.
B. Standard or high-pressure, system piping shall be one of the following:
   1. Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; galvanized grooved-end-pipe couplings for steel piping; and grooved joints.
C. High pressure fittings and couplings shall be rated for a minimum of 300 psi.
D. Drain piping extending through the exterior wall shall be galvanized with galvanized fittings.
E. Fire department connection piping extending through the exterior wall shall be galvanized.
F. Piping between Fire-Department Connections and Check Valves: Galvanized, Schedule 40 steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
G. System piping installed outdoors or in damp or humid areas shall be galvanized with galvanized fittings and couplings.

END OF SECTION 211339

SECTION 213116 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. The Contractor shall furnish all labor, materials, and equipment for a fully operating fire pump system in full compliance with NFPA 20, NFPA 70, NFPA 72, NFPA 13, and all other codes, regulations and laws applicable to the work, and in full compliance with the intent of the plans and Specifications, including all work inferable from same.

B. Section Includes:
   1. Split-case fire pumps.
   2. Fire-pump accessories and specialties.
   3. Flow meter systems.
   4. Fire pump controllers.
   5. Fire pump test connections.
   6. Fire pump startup and testing.

C. Related Sections
   1. SECTION 211313 – AUTOMATIC SPRINKLER SYSTEMS
   2. SECTION 211339 - LOW EXPANSION FOAM SYSTEMS.
   3. SECTION 283100 - FIRE ALARM SYSTEMS.

1.03 REFERENCES:

A. Applicable Standards:
   1. 2022 Portland Specialty Structural code (PBC)
   2. 2022 Portland Fire Code (PFC)
   3. Local Codes including local policies, interpretation, and standards.
   4. ANSI
      a. ANSI/HI 1.4-2014 – Rotodynami Centrifugal Pumps for Manuals describing Installation, Operation, and Maintenance
   5. FM Global:
      a. FM Approval Guide.
   6. NFPA:
      a. NFPA 11 – Standard for Low-, Medium, and High-Expansion Foam Systems (2016)
      b. NFPA 13 - Standard for the Installation of Sprinkler Systems (2019)
      c. NFPA 20 - Standard for the Installation of Stationary Fire Pumps for Fire Protection (2019).
      d. NFPA 70 - National Electrical Code (2020)
      e. NFPA 1963 - Fire Hose Connections (2019).
   7. Underwriters Laboratories Inc. (UL):
      a. Fire Protection Equipment Directory.

1.04 PERFORMANCE REQUIREMENTS:

A. Pump Equipment, Accessory, and Specialty Pressure Rating: 200 psig minimum unless higher pressure rating is indicated.

1.05 SUBMITTALS:

A. Shop Drawings: Prepare shop drawings, product data sheets and hydraulic calculations for the complete fire pump system in accordance with NFPA Standard 20 and NFPA Standard 13.
   1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
      a. Product data sheets shall be annotated to indicate the model, options, sizes, rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories that will be provided. Cut sheets with multiple models, options and sizes that are not annotated will not be accepted.
      b. Submit certified fire pump performance curve when it is available. This is not required to be submitted concurrently with the product data.
   2. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties, and fire pump controllers. Include plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Schematic and Connection Diagrams: For power, signal, and control wiring and pressure sensing tubing.
   3. Shop drawings resubmittals shall be accompanied by a response letter addressing each comment in the Engineer's review of the shop drawings. Changes to the working plans shall be clouded to indicate the revised area and annotated to indicate the revision number and revision date.

B. The Fire Protection Contractor shall employ the services of a qualified fire protection technician certified at Level III with N.I.C.E.T. in Water Based Systems Layout to prepare and sign the sprinkler system shop drawings and hydraulic calculations for submittal.

C. Submit shop drawings and hydraulic calculations to the Authorities Having Jurisdiction for review.

D. Submit shop drawings and hydraulic calculations as specified in SECTION 013300 - SUBMITTALS to the Architect and Engineer for review.

1.06 CLOSEOUT SUBMITTALS:

A. As-built documents: Submit as-built documents in accordance with DIVISION 01 CONTRACT CLOSE OUT. Provide as-built drawings and product data sheets.

B. Operation and Maintenance Data: Submit operations and maintenance manuals in accordance with DIVISION 01 CONTRACT CLOSE OUT. Provide product operations and maintenance information and instructions, fire pump acceptance testing results including all applicable NFPA 20 acceptance testing forms.

C. Submit manufacturer's certified fire pump test curve.

1.07 QUALITY ASSURANCE:

A. Compliance with FM Global Property Loss Prevention Data Sheets is mandatory.

B. Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for

the word "should" wherever it appears. In the event of a conflict between specific provisions of this Specification and applicable NFPA standards, this Specification shall govern.

C. Installer Qualifications:
   1. The Contractor for the fire protection installation shall be a qualified Fire Protection Contractor, regularly engaged in the installation of fire pump systems.
   2. Installer's responsibilities include designing, fabricating, and installing fire pumps systems and providing professional engineering services needed to assume engineering responsibility.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified fire protection technician certified at Level III with N.I.C.E.T. in Water Based Systems Layout.

D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.08 COORDINATION:

A. Coordinate layout and installation of fire pumps and controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. All components of the fire pump system shall be UL-Listed and FM Approved for use in fire protection systems.

B. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 FIRE PUMPS:

A. Basis of Design Product: Subject to compliance with requirements, provide Aurora model 5-481-15 or comparable product by one of the following:
   1. Aurora.
   2. Engineer approved substitute.

B. Pump Requirements:
   1. Fire pump shall be of equivalent model and capacity scheduled. The pump shall deliver not less than 150% of rated flow capacity at not less than 65% of the rated net pressure.
   2. The pump shutoff pressure shall not exceed 140% of the rated pressure.
   3. Fire pumps shall be factory-assembled and tested fire pump and driver unit. Fire pump assembly shall be finished with red paint applied to factory-assembled and -tested unit before shipping.
   4. The fire pump capacity shall be such that the maximum system demand does not exceed 140% of the pump rated flow capacity.
   5. Fire pump shall be UL-Listed (UL 448) and FM Approved.
   6. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections. Minimum 200 psig rated.
   7. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   8. Wear Rings: Replaceable bronze.
   9. Shaft and Sleeve: Steel shaft with bronze sleeve.
      a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.

b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

10. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Driver:
1. Standard: UL 1247 and FM Approved.
2. Type: Diesel engine.
3. Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
a. Piping: ASTM B88, Type L copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8, BCuP Series brazing filler metal; and brazed joints.
4. Dual Batteries: Lead-acid-storage type with 100% standby reserve capacity.
5. Fuel System: Comply with NFPA 20.
a. Fuel Storage Tank: Double wall tank, UL 142. Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gauge, and secondary containment tank with capacity at least equal to fuel storage tank.
6. Exhaust System: ASTM A53, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Provide double wall thimble for wall penetrations.
a. Exhaust Connector: Flexible type.
b. Exhaust Silencer: Industrial type.

E. Capacities and Characteristics:
1. Rated Capacity: 1,000 gpm.
2. Total Rated Head: 85 psig.
3. Inlet Flange: Class 125.
4. Outlet Flange: Class 150.
5. Engine Horsepower: 65 BHP
6. Engine Speed: 1,760 rpm.
7. Fuel Tank Capacity: Minimum per NFPA 20.

F. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

2.03 FIRE-PUMP ACCESSORIES AND SPECIALTIES:

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

C. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

D. Hose Valve Manifold Assembly:
1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A53, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
a. System must be manufactured and hot-dipped galvnized as one assembly
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726 and FM Approved.
5. Manifold:
a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets. FM Approved.
b. Body: Flush type, galvanized steel, with 6 outlets.
c. Nipples: ASTM A53, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.

d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Exposed Parts Finish: Polished chrome plated.
g. Escutcheon Plate Marking: Equivalent to "FIRE SYSTEM TEST."

E. Gauges:
1. Pressure gauges on the suction and discharge of fire pump shall be oil filled.

F. Flow Meter Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Gerand Engineering Co.
b. Global Vision.
c. Victaulic Company.
d. Engineer approved substitute.
2. Description: UL-listed and FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 1750 gpm.
3. Pressure Rating: 200 psig minimum.
4. Sensor: Venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
5. Permanently Mounted Flow meter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.
a. Tubing Package: NPS 1/8 or NPS 1/4 soft copper or plastic tubing with copper or brass fittings and valves.

2.04 PIPING, FITTINGS AND VALVES:

A. Piping, fittings and valves not otherwise specified in this Section shall comply with SECTION 211313 – AUTOMATIC SPRINKLERP SYSTEMS.

B. All valves shall be supervised in accordance with SECTION 211339 - LOW EXPANSION FOAM SYSTEMS. Valves on jockey pump piping shall be sealed in the open position and shall not be electronically supervised.

2.05 FIRE PUMP CONTROLLER:

A. Basis of Design Product: Subject to compliance with requirements, provide Emerson Firetrol FTA1100-J or comparable product by one of the following:
1. Aquarius Fluid Products, Inc.
2. ASCO Power Technologies, LP; Firetrol Products.
3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Hubbell Incorporated; Hubbell Industrial Controls.
5. Joslyn Clark Corporation.
6. Master Control Systems, Inc.
7. Metron, Inc.
8. Tornatech.
9. Engineer Approved Substitute

B. General Requirements for Controllers:
1. Comply with NFPA 20 and UL 218.
2. UL Listed and FM Approved for diesel-engine driver for fire-pump service.
3. Combined automatic and non-automatic operation.
4. Factory assembled, wired, and tested.

C. Method of Starting:
1. pressure-switch actuated.

a. Solid state wye-delta pressure switch shall be used for both display of the system pressure and control of the fire pump controller. Systems using analog or mechanical pressure devices or mercury switches for operational control will not be accepted.
b. Digital system pressure recorder.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Dual, redundant dc-voltage battery units, with automatic changeover.
3. Emergency Control: Bypasses all automatic control circuits during manual starting and running.

D. Method of Stopping: Manual.

E. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.
3. Local Alarm and Status Indications:
a. Controller power on.
b. Engine-lubrication-system critically low oil pressure.
c. Engine-jacket coolant high temperature.
d. Engine fail-to-start.
e. Engine overspeed shutdown.
f. Low fuel level.
g. Missing or failed battery.
h. Battery charger failure.
i. ECM selector switch in alternate ECM position.
j. Fuel injector malfunction.
k. Low pump room temperature.
4. Audible alarm.
5. Nonautomatic START and STOP push buttons or switches.

F. Optional Features:
1. Operator Interface Communications Ports: USB, Ethernet, and RS485.
2. Each diesel fire pump control panel shall have two sets of normally open, dry, isolated, 120 VAC, 10 A, auxiliary “fire pump running” contacts (contacts closed when fire pump is running) to allow interlocking of the fire pump room exhaust ventilation systems and dampers

G. Battery Charger System:
1. Built-in, independent, dual battery chargers with automatic changeover; 12-V dc or 24-V dc for lead-acid batteries in a covered, clear-topped floor stand elevated 12” above the floor.
2. Standard: UL 1236 and FM Approved.

H. Remote monitoring:
1. The fire suppression control panel shall monitor the fire pump controller. Provide contacts for remote monitoring of the following conditions:
a. Pump Operating.
b. Controller main switch off or manual.
c. Controller Trouble.

I. Enclosures:

1. Fire pump controller enclosures shall be NEMA 250, Type 2.
2. Enclosures shall be mounted minimum 12 inches above finished floor. Provide with floor stands 12 inches high for floor mounted controllers.

2.06 GROUT:

A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink and recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.07 SOURCE QUALITY CONTROL:

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   1. Verification of Performance: Rate fire pumps according to UL 448.
B. Fire pumps will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine equipment bases and anchorage provisions for compliance with requirements and for conditions affecting performance of fire pumps and controllers.
B. Examine equipment before installation. Reject equipment that is damaged in any way.
C. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps and related components.
B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in DIVISION 03.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20. Piping shall be sized to flow a minimum of the total system demand.
D. Support piping and pumps separately so weight of piping does not rest on pumps.
E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in SECTION 211339 - LOW EXPANSION FOAM SYSTEMS.
F. Install pressure gauges on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gauges specified in SECTION 211339 - LOW EXPANSION FOAM SYSTEMS.
G. Install piping hangers and supports, anchors, valves, gauges, and equipment supports according to NFPA 20 and NFPA 13.

H. Supports for copper piping shall be copper plated or felt lined.
I. Install fuel system according to NFPA 20.
J. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to water tank return.
K. Insulate and heat trace all normally filled piping outside the building.
L. Install exhaust-system piping for diesel engine. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.
M. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
N. Install controllers within sight of their respective drivers.
O. Mount controllers in accordance with one of the following:
    1. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with DIVISION 26.
    2. Floor-Mounting Controllers: Install controllers on 4-inch nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in DIVISION 03.
        a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
        b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
        c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
        d. Install anchor bolts to elevations required for proper attachment to supported equipment.
P. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
Q. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
R. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
S. Air pressure test fuel piping prior to final connections.

3.03 ALIGNMENT:

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
C. Align piping connections.
D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.04 CONNECTIONS:

A. Comply with requirements for piping and valves specified in SECTION 211339 - LOW EXPANSION FOAM SYSTEMS. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps and equipment to allow service and maintenance.
C. Pipe fire pump packing drain cavities to floor drain or as indicated on the drawings with rigid copper pipe and soldered fittings.
D. Connect flowmeter-system meters, sensors, and valves to tubing with manufacturer-mandated straight piping sections up and downstream as required.
E. Connect fire pumps to their controllers. All wiring shall be in accordance with DIVISION 26.
F. Provide 1/2-inch rigid copper or brass sensing lines between fire pump discharge piping and fire pump controller and between jockey pump discharge piping and jockey pump controller. Each controller shall be provided with separate sensing lines. Connect to discharge piping as far from the discharge check valve and as near to the discharge shutoff valve as possible. Provide orifice check valves, pressure gauges and other accessories as required by NFPA 20.
G. Provide dielectric union at connection of copper to ferrous materials.
H. Power for fire pump controller and jockey pump will be provided under DIVISION 26.
I. Fire alarm monitoring of controllers will be provided under DIVISION 28.

3.05 IDENTIFICATION:

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.06 FIELD QUALITY CONTROL:

A. Test each fire pump with its controller as a unit.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Acceptance Testing Preparation:
    1. Inspect and Test Each Component:
    2. Verify and Test Each Diesel Engine-Driver Controller:
    3. Operational Test: Start units to confirm proper unit operation.
    4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
E. Tests and Inspections:
    1. Perform hydrostatic test.
    2. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Engineer, Owner and authorities having jurisdiction.
    3. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing. Provide minimum 15 business day notice.
    4. Engage manufacturer's factory-authorized service representative to be present during the testing.
    5. Test according to NFPA 20 for acceptance and performance testing.
F. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
G. Prepare test and inspection reports.

H. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.07 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

B. Fire pumps and jockey pump wye delta start and stop settings shall be in accordance with NFPA 20 Annex A.
   1. Jockey pump stop shall be fire pump churn pressure plus water supply static pressure: Approximately 195 psi.
   2. Jockey pump start shall be jockey pump stop -10 psi: Approximately 185 psi.
   3. Fire pump 1 start shall be jockey pump start -5 psi: Approximately 180 psi.
   4. Actual settings shall be calculated by the contractor and based on certified pump curve and tank head pressure.

C. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

D. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

E. Lubricate pumps as recommended by manufacturer.

F. Set field-adjustable pressure switches.

G. Fill fuel tanks. Provide all fuel necessary for testing of fire pumps and suppression systems. Top off fuel tank at job completion.

3.08 DEMONSTRATION AND DOCUMENTATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

B. Provide posted operating instructions for pumps, drivers, controllers and flow meters. Instructions shall be framed and permanently mounted adjacent to the fire pump controller or at location approved by Owner.

END OF SECTION 213116

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SECTION 25 30 01 - INSTRUMENTATION FOR FUEL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers major electrical instrumentation and devices applicable to the fuel system.
B. Unless otherwise indicated in the appendix, 25 30 01A Instrument Schedule, all instruments and devices shall be procured, installed and wired by the ELECTRICAL SUBCONTRACTOR.
C. Extent of Work shall be as follows:
   1. Coordinate all work with DIVISION 25 and DIVISION 33. Provide all services hereinafter, including final system performance verification, to ensure the system functions as specified. Refer to DIVISION 25 and 33 sections for requirements for interfacing controls and instrumentation with mechanical equipment and systems.
   2. Conform to DIVISION 26 sections for raceways, cables and conductors, terminations and splices, boxes, cabinets, supports, hangars, seals and other applicable requirements governing the installation of the electrical components of the controls system, unless specified otherwise in this Section.
   3. All instrumentation and their components shall meet the following requirements:
      a. Be furnished, installed, tested and put into successful operation.
      b. Be complete with all necessary accessories, add-ons and capabilities whether indicated on the Drawings or not but required for a complete and functional system.
      c. Meet the requirements of applicable codes and standards as specified.

1.03 RELATED REQUIREMENTS:

A. DIVISION 26 - Electrical Work.
B. Section 25 50 01 - Facility Controls for Fuel Systems.
C. Section 25 90 01 - Control Sequences for Fuel Systems.
D. Section 33 52 43 - Fuel System General Requirements.
E. Section 33 52 47 - Fuel System Valves
F. Section 33 52 48 - Fuel System Accessories.
G. Section 33 52 50 - Fuel System Pumps.
H. Section 33 52 51 - Fuel System Filtration
I. Section 33 56 41 - Shop Fabricated Aboveground Storage Tanks
J. Section 33 56 43 - Fuel System Aboveground Storage Tanks (Field Fabricated)
K. Section 33 56 45 - Aboveground Oil Water Separators

1.04 REFERENCE STANDARDS:

A. Refer to the individual sections listed under the above Article 1.03 (Related Requirements).

1.05 DEFINITIONS:

A. FS: Flow Switch.
B. FIT: Flow Indicating Transmitter.
C. LI: Level Indicator
D. LS: Level Switch.
E. LIT: Level Indicating Transmitter

F. MS: Moisture Switch.
G. PDS: Pressure Differential Switch.
H. PIT: Pressure Indicating Transmitter.
I. TSH: Temperature Switch High.
J. TIT: Temperature Indicating Transmitter.
K. UIT: Multivariable Indicating Transmitter.
L. VIT: Vibration Indicating Transmitter.

1.06 SUBMITTALS:

A. Submittals shall include, but not be limited to, the following:
   1. Product Data: Before any work is commenced, submit the complete manufacturers descriptions, catalog data and information for each item below:
      a. Flow Switches.
      b. Flow and Temperature Switches
      c. Flow Meters & Flow Indicating Transmitters.
      d. Moisture Switches.
      e. Pressure Differential Switches.
      f. Pressure Indicating Transmitters.
      g. Temperature Switches.
      h. Temperature Indicating Transmitters.
      i. Vibration Indicating Transmitters.
      j. Level Switches.
      k. Level Indicating Transmitters
      l. Level Indicator
      m. Exterior Horns.
   2. Wiring Diagrams: Submit power and control schematic and wiring diagrams for instruments. Differentiate between portions of wiring which are manufacturer factory installed and portions which are field-installed.

PART 2 - PRODUCTS

2.01 LISTING:

A. All products and equipment shall be UL listed.

2.02 GENERAL:

A. Provide products in sizes and capacities indicated, and as required by the application and Contract Drawings. Products shall conform to manufacturer's standard materials and components as published in their product information. All furnished products, including those listed in the Specifications by manufacturer and model number, will be acceptable subject to meeting all contract requirements.

2.03 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Flow Switches (FS):
      a. Ameritol, Inc. (FX Series).
   2. Flow and Temperature Switches (FSTS):
      a. Ameritol, Inc. (FX Series).
   3. Moisture Switches (MS) and Water Detection Systems:

a. Gammon Technical Products.
4. Pressure Indicating Transmitters (PIT):
   a. Rosemount (3051C).
5. Differential Pressure Indicating Transmitters (DPIT):
   a. Rosemount (3051C).
6. Temperature Indicating Transmitters (TIT):
   a. Rosemount (model 644).
7. Thermowell and RTD:
   a. Rosemount (model 68)
8. Vibration Indicating Transmitters (VIT):
   a. Metrix (model ST5491E).
9. Level Switches (LS) :
   a. Magnetrol (model A15)
10. Exterior Horns
    a. Edwards Signaling (model 5531M)
11. Automatic Tank Gauging (ATG)
    a. Rosemount
12. Leak and Level Detection Panel (LLDP)
    a. Veeder-Root
    b. Pneumercator

2.04 FLOW SWITCHES (FS):

A. Flow switches shall be solid state electronic thermal dispersion type flow switch, rated for 600 psig maximum working pressure at 100ºF, 316 stainless thermal flow probe, 1-inch NPT (Class 3,000 thread-o-let) process connection.
   1. Electrical: 120 Vac power supply, double-pole, double-throw (DPDT) relay outputs. Flow threshold point adjustable from 0.01 to 5 feet per second -40°F to +160°F.
   2. Relay rating: 3A at 120/240 Vac
   3. Flow switches shall be suitable for installation in Schedule 40 piping, sizes as indicated on the drawings.
   4. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
   5. Enclosure: Explosion Proof.
   6. Acceptable Manufacturer: Ameritol, Inc., model FX.

2.05 FLOW AND TEMPERATURE SWITCHES (FSTS):

A. Flow and temperature combination switches shall be solid state electronic thermal dispersion type flow switch, rated for 600 psig maximum working pressure at 100ºF, 316 stainless thermal flow probe, 1-inch NPT (Class 3,000 thread-o-let) process connection.
   1. Electrical: 120 Vac power supply, single-pole, double-throw (SPDT) relay outputs. Flow threshold point adjustable from 0.01 to 5 feet per second -40°F to +160°F.
   2. Relay rating: 3A at 120/240 Vac
   3. Flow and temperature combination switches shall be suitable for installation in Schedule 40 piping, sizes as indicated on the drawings.
   4. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
   5. Enclosure: Explosion Proof.
   6. Acceptable Manufacturer: Ameritol, Inc., model FX.

2.06 MOISTURE SWITCHES (MS) AND WATER DETECTION SYSTEMS:

1. Water detection probes (moisture switches):
   a. Design Requirements: Water detection system shall be single stage, 120 Vac.
   b. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
   c. Enclosure: Explosion Proof.
   d. Water detection probe shall be testable in its operating position.
   e. System shall have a minimum of two relay contacts rated for continuous 10A at 120 Vac.
   f. System Operation: Water detection probe / assembly shall energize a relay coil when no water has been detected. When water is detected the relay coil shall de-energize. When power is removed from probe / assembly the relay coil shall also de-energize.
      (1) Relay Contact #1 (Dry Contact): Contact shall be open when relay coil is de-energized (N/O). This state occurs when water has been detected. When no water has been detected, relay coil is energized causing the contacts to close. Contacts will be wired to the associated control valve (signal 120 Vac).
      (2) Relay Contact #2 (Dry Contact): Contact shall be open when relay coil is de-energized (N/O). This state occurs when water has been detected. When no water has been detected, relay coil is energized causing the contacts to close. Contacts will be wired to the PLC (signal 120 Vac).
   g. Process connection size shall be ¾-inch.
   h. Acceptable manufacturer: Manufacturer and model shall be Gammon GTP-1750-5-1-3-1-3-3-3-5 (based on probe model GTP-9330) with additional non-standard contacts indicated or approved equal.

2.07 PRESSURE INDICATING TRANSMITTERS (PIT):

A. Pressure indicating transmitters shall be explosion-proof, with two wire 4-20mA output over its indicated and specified range with local LCD display. Pressure measurement shall be 0.025% (minimum) with 150:1 turndown.
B. Factory set pressure/calibrated range: 0 to 300 psig.
C. Isolation diaphragm shall be 316L stainless steel.
D. Pressure indicating transmitters shall be assembled to a manifold. Manifolds shall be comprised of block-and-bleed instrument valves (two-valve, isolation and vent) connections. Valves shall be 316 stainless steel with PTFE stem seal material. Process connection shall be ½-14 NPT female.
E. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
F. Enclosure: Explosion Proof.
G. Acceptable Manufacturer: Rosemount model 3051C Coplanar Pressure Transmitter with model 306 integral manifold or approved equal.

2.08 DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS (DPIT):

A. Differential pressure indicating transmitters shall be explosion-proof, with two wire 4-20mA output over its indicated and specified range with local LCD display. Pressure measurement shall be 0.035% (minimum) with 150:1 turndown.
B. Factory set pressure/calibrated ranges: 0 to 20 psi.
C. Isolation diaphragm shall be 316L stainless steel.

D. Pressure indicating transmitters shall be assembled to a manifold. Manifolds shall be comprised of block-and-bleed instrument valves (two-valve, isolation and vent) connections. Valves shall be 316 stainless steel with PTFE stem seal material.
E. Acceptable Manufacturer: Rosemount model 3051C Coplanar Pressure Transmitter with model 306 integral manifold or approved equal.
F. Pipe mounting bracket shall be stainless steel and shall be furnished by the pressure indicating transmitter manufacturer. Pipe mounting bracket shall be suitable for fastening the pressure indicating transmitter and integral manifold to the filter separator.

2.09 TEMPERATURE INDICATING TRANSMITTERS (TIT):

A. Temperature transmitters shall be two wire, loop powered, with a 4-20mA output over its specified range. It shall have an integral LCD display.
B. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
C. Enclosure: Explosion Proof.
D. Factory set temperature range: 0ºF to 300ºF.
E. One temperature transmitter shall be provided for the HCTS/Transfer pump TP-1. See Section 33 52 50 - Fuel System Pumps for additional requirements.
F. Instrument connection shall be coordinated with the fuel pump manufacturer.
G. Acceptable Manufacturer: Rosemount model 644.

2.10 THERMOWELL AND RTD (RESISTANCE TEMPERATURE DETECTOR) FOR HCTS/TRANSFER PUMP (TP-1):

A. General Requirements for Thermowells:
   1. Thermowell shall be 316 stainless steel stepped shank.
   2. Process connection shall be 1-inch NPT, male. Final size shall be coordinated with Contractor-approved transfer pump manufacturer.
   3. Temperature sensor insertion connection size shall be ½-inch NPT, female.
   4. Bore size shall be 0.260 inches.
   5. Thermowells shall be installed with a conductive heat transfer compound.
   6. Instrument connection shall be coordinated with the HCTS/Transfer pump (TP-1) manufacturer.
   7. Acceptable Manufacturer: Rosemount.
B. General Requirements for RTD Temperature Sensor:
   1. Temperature sensor shall be for insertion and installation in thermowell.
   2. Temperature sensor shall be 4-wire 100-Ohm high purity platinum wire RTD.
   3. Resistance at 32ºF shall be 100 Ohms.
   4. Temperature Coefficient at 32°F to 212ºF shall be 0.00385 Ohm/Ohm/ºF.
   5. Sheath diameter shall be 1/4-inch.
   6. Thermowell insertion connection size shall be 1/2-inch NPT, male.
   7. RTD leads shall be brought out to an RTD compatible Class I, Divisions 1 and 2, Group D rated connection head with terminal block and 3/4-inch NPT conduit connection. Terminal head shall be explosion proof.
   8. Acceptable Manufacturer: Rosemount model 68.

2.11 VIBRATION INDICATING TRANSMITTERS (VIT):

A. Vibration transmitters shall be two wire, loop powered, with a 4-20mA output over its specified range. It shall have an integral LCD display.
B. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.

C. Enclosure: Explosion Proof.
D. Vibration transmitters' 4-20mA with a peak velocity of 0.5 inches per second.
E. Two pump bearing vibration transmitters shall be provided per transfer pump. See Section 33 52 50 - Fuel System Pumps for additional requirements.
F. Instrument connection shall be coordinated with the transfer fuel pump manufacturer.
G. Acceptable Manufacturer: Metrix model ST5491E.
H. Refer to Section 33 52 50 - Fuel System Pumps for additional requirements.

2.12 LEVEL SWITCHES (LS):

A. General: Provide level switches as indicated on Drawings. Prior to submitting shop drawings, coordinate instrument connections with existing conditions (when applicable) and fabrication drawings. Switches shall have a permanently attached stainless steel nameplate with the instrument tag number (per P&ID). In addition, the instrument vendor shall provide a wired on stainless steel nametag with the instrument tag number.
B. Provide the following level switches:
    1. Jet A Storage Tanks (LSHH-TK#):
        a. Magnetrol level switch model A15 (narrow differential type) with a single level set points (high-high level). Displacer to be compatible with jet fuel and selected such that it will operate in a minimum specific gravity of 0.78. The switch mechanism shall be hermetically sealed, N.O./N.C., double-pole, double-throw (DPDT). Contacts to be rated a minimum of 1A @ 120 VAC. Displacer shall have proof-er (method of testing switching mechanism without removal from the process).
        b. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
        c. Enclosure: Explosion Proof.
        d. Process Connection: 6-inch, Class 150 Flange (installed in fixed cone roof)
        e. Level Set Points: See Levels of Concern Table within specification 25 90 01.
    2. Dewatering Sump (LSH-DW#):
        a. Single level set point (high level)
        b. Float compatible with jet fuel. Selected that it will operate in a minimum specific gravity of 0.78.
        c. The switch mechanism shall be hermetically sealed, N.O./N.C., double-pole, double-throw (DPDT). Contacts to be rated a minimum of 1A @ 120 VAC.
        d. Hazardous Rating: Suitable for installation in Class 1, Division 1, Group D location.
        e. Enclosure: Explosion Proof.
        f. Manufacturers:
            (1) ABB K-TEK MS50 level switch.
            (2) AMETEK L500S level switch
        g. Process Connection: Coordination connection requirements with dewatering sump.
        h. Level Set Points: See Levels of Concern Table within specification 25 90 01

2.13 EXTERIOR HORNS:

A. General: Provide exterior horns as indicated on Drawings.
B. Design Requirements:
    1. Horns shall be rated for installation in interior or exterior locations as shown in contract Drawings.
    2. Horns shall operate from 115 Vac power supply.

3. Volume output shall be adjustable. Adjustable range shall be between 75 dB – 110 dB at 10 feet.
4. Horn shall be capable of four unique tones to annunciate or alarm per input received. Coordinate tone selection with Operator. Adjacent horns shall have different tones.
5. Horns shall annunciate per contract documents.

C. Manufacturer and Model: Edwards Signaling Adaptatone Millennium Series 5531M (or approved equal).

2.14 AUTOMATIC TANK GAUGING SYSTEM:

A. General: Provide replacement components for the existing automatic tank gauging system for each vertical storage tank. Field verify and coordinate lengths and instrument connections with field conditions and equipment furnished prior to submitting shop drawings.

B. Tank gauging system shall meet or exceed inventory and custody transfer specifications as defined in the following:
1. API 3.1B; Inventory and Custody Transfer.
2. API Chapter 7; Temperature Measurement.

C. Set Points: Provide programmable set points:
1. High-High
2. High
3. Maximum Working
4. Low
5. Low-Low

D. The following existing instruments shall be salvaged and turned over to owner.
1. Emerson/Rosemount Level Gauge (three total).
2. Emerson/Rosemount 2410 Tank Hubs (three total).
3. Emerson/Rosemount 3051S Pressure Transmitter (three total).
4. Emerson/Rosemount 2460 System Hub (Tank Gauge Interface, one total for ATG system).

E. Provide the following instruments as part of a complete automatic tank gauging system for each new bulk storage tank:
1. Emerson/Rosemount 5900S Radar Level Gauge with still-pipe array antenna.
   a. Dual independent radar level gauge 2-in-1 functionality.
   b. Intrinsically safe Tankbus communication.
   c. FM approved for Class I, Division 1, Group D.
   d. Connection size as indicated on plan drawings.
   e. Engraved stainless-steel tag plate.
2. Emerson/Rosemount 2240S Multi-Point Temperature Transmitter and Probe.
   a. Multi-point temperature measurement. Minimum of 8 points. Rosemount 565 Temperature Sensor.
   b. Intrinsically safe Tankbus communication.
   c. FM approved for Class I, Division 1, Group D.
   d. Connection size as indicated on plan drawings.
   e. Engraved stainless-steel tag plate.
3. Emerson/Rosemount 3051S Pressure Transmitter.
   a. Loop powered 4-20mA.
   b. FM approved for Class I, Division 1, Group D.
   c. Connection size as indicated on plan drawings.
   d. Engraved stainless-steel tag plate.

4. Emerson/Rosemount 2410 Tank Hubs.
    a. Intrinsically safe Tankbus communication.
    b. FM approved for Class I, Division 1, Group D.
    c. Engraved stainless-steel tag plate.
5. Emerson/Rosemount 2460 System Hub (Tank Gauge Interface)
    a. Capacity of 1-16 tanks.
    b. Firmware capable of inventory calculation.
    c. Modbus TCP enabled ports for communication with Fuel Control System PLC.
    d. Fieldbus communication with field mounted Tank Hub.

F. Provide Emerson/Rosemount service engineer. Contract with Emerson/Rosemount for ATG configuration and commissioning.
1. At minimum Emerson/Rosemount shall budget two trips to site. One trip to commission the system and a follow up trip to make any required adjustments.

2.15 LEAK & LEVEL DETECTION PANEL:

A. General: Provide Leak & Level Detection Panel for monitoring of the Reclaim Tank and Sump Pit.
1. Control Unit: The control unit shall monitor continuous level of tanks and moisture leak sensor as shown on Contract drawings. Control unit shall be housed in a NEMA Type 1 enclosure as required, for wall mounting, with an operating temperature range no less than 32°F to 104°F. The front face shall contain a full LCD touch panel. Display shall indicate tank levels and alarms. The unit shall be microprocessor controlled and programmed to the specific tank configurations with a resolution of 0.1-inch of liquid level in each tank. Control unit shall allow for testing and adjusting calibrations and setting high/low warning alarms. Control unit shall allow for off-set adjustments to be made for easy field correction of level sensor installation height error. The control unit shall operate from 115 VAC. Control unit shall be capable of communicating simultaneously over ethernet and RS-485. Relay alarm contacts shall be SPDT – 5 amp rated. Unit shall supply intrinsically safe DC voltage to operate all leak and level sensors.
2. Reclaim Tank Level Transmitter Assembly:
    a. Provide a resistive sensor/transmitter element bonded to a 10% glass filled polycarbonate track, and hermetically sealed within a stainless steel vertical tube suspended into the tank through a 4-inch NPT opening.
    b. A magnetic float, selected for the specific gravity of the liquid, is guided along the tube. The sensor continuously senses the liquids level position to 0.1-inch accuracy and is unaffected by conductivity, temperature, pressure.
    c. Sensor shall be rated 50 psig.
    d. Sensor shall be rated 180°F.
    e. Assembly shall be rated for Class I, Division 1 and UL Listed.
3. Interstitial Leak Sensor (LD):
    a. Interstitial non-discriminating sensor to monitor presence of liquid in annular space of double-wall steel tanks as indicated on drawings.
    b. UL Listed.
4. Overfill Alarm Horn & Acknowledgement Switch
    a. Programmable to alarm on Diesel or Gasoline leak/level alarms.
    b. Audible alarm with adjustable output (78-103dB at 10 feet).
    c. Visual alarm flashing at 75 flashes per minute.
    d. Visual and audible horn shall be powered by 120Vac.

5. Solid State Discriminating Dispenser Pan & Containment Sump Sensors (LD-14).
   a. Detects the presence of, and differentiates between, hydrocarbons and other liquids.
   b. Sensor shall be reusable after an alarm condition without degradation even after exposure to heavy concentration of hydrocarbons.
6. Provide all I/O and communication cards for additional sensors, inputs, outputs, and communication with Fuel System Control Panel.
7. Acceptable Manufacturers: Manufacturer shall be Veeder-Root or Pneumercator.
8. Coordinate probe lengths with tank manufacturer. Refer to Section 33 56 41 Shop Fabricated Aboveground Storage for tank requirements.
9. Provide surge protection for field wiring.

PART 3 - EXECUTION

3.01 GENERAL:

A. Install all system components in accordance with manufacturers' recommendations, rough-in Drawings and details on Drawings. Provide all necessary interconnection, services, and adjustments necessary for a complete and operable system. All electrical work shall be accordance with the NEC and DIVISION 26 of these specifications. All setpoints and the operating sequences are approximate initial values only. All setpoints shall be adjustable.

3.02 DELIVERY, STORAGE, AND HANDLING:

A. Deliver products to the Project Site properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
B. Store Equipment and components in original packaging and in a clean dry space; protect from weather and construction traffic.
C. Handle Equipment and components carefully to avoid breakage, impact, denting, and scoring of finishes. Do not install damaged Equipment; replace and return damaged units to Equipment manufacturer.
D. Spare Parts: Where spare, replacement, or additional parts are required for the equipment specified herein, these items shall be delivered to the Contractor immediately upon receipt at the job site. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of equipment to which they apply. Provide spare parts lists for instruments and equipment specified in this Section.

3.03 PREPARATION:

A. Examine the areas and conditions under which the instrumentation is to be installed, and remedy conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected. Beginning of installation means installer accepts existing conditions.
B. Before the installation of electrical equipment, conduit, and outlets, check the approved shop drawings for any necessary deviations required in work. When interference makes it necessary, or departure from the indicated arrangements is desired, obtain permission from Contractor prior to commencing the installation.
C. Cut all necessary openings, chases, ditching, backfilling, etc. required for the introduction of the work. Damage caused by such cutting shall be repaired at no additional cost to the Contractor.

3.04 INSTALLATION:

A. Install complete as specified, indicated, or required for operation and continuous service at the locations indicated.
B. Conform to manufacturer's recommendations.
C. Provide all openings in floors, walls, roofs, and other structures necessary for complete equipment installation, unless such openings are specifically indicated as being provided by others. Seal penetrations in fueling areas as required by DIVISION 2 and DIVISION 3.
D. Level, shim, and anchor to floor or structure with bolts or cinch anchors, and grout all floor-mounted equipment.
E. Install all necessary wiring or interconnections as required.
F. Make all internal and external connections and tighten as required.
G. Check all internal and external connections and tighten as required.

3.05 TESTING:

A. General: Provide Contractor-approved operation and acceptance testing of all equipment. The Contractor shall witness all tests. The tests shall be scheduled at least one week in advance, with the equipment manufacturer's, Contractor's, and Owner's representatives present during the test. Any defects which become evident at this time shall be corrected and, if required by the Contractor, additional tests, or new tests shall be made to ensure that the results of the operational tests are satisfactory, without defects, prior to final acceptance.
    1. Final acceptance testing of the components in this Section shall be done in conjunction with the testing Sections in Section 25 50 01 - Facility Controls for Fuel Systems.
B. Field Test: When installation of the system is complete, the Mechanical Subcontractor, Electrical Subcontractor and System Integrator shall calibrate equipment and verify system operates correctly before the system is placed on-line. The Mechanical Subcontractor, Electrical Subcontractor and System Integrator shall coordinate all functional testing, calibrating, adjusting, and final field tests. Provide a detailed cross- check of each sensor within the system by making a comparison between the control command and the field-controlled device. Verify that all systems are operable from local controls in the specified failure mode upon PLC failure or loss of power. Mechanical Subcontractor shall submit the results of functional and diagnostic tests and calibrations to the Contractor for final system approval.

END OF SECTION 25 30 01

INSTRUMENT SCHEDULE

INSTRUMENT TAG NO.	INSTRUMENT TYPE	COMMENTS	HAZARDOUS RATING	LOCATION PLAN	ELEC. RISER PLAN	P&ID	EQUIPMENT / PIPE	SPECIFICATION	PROCURED BY	INSTALLED ON EQUIPMENT BY	WIRED BY	POWER REQ. (VOLTS/PHASE)	ELECTRICAL OUTPUT
LSHH-T5	LEVEL SWITCH - DISPLACER	1 POSITION LEVEL SWITCH WITH PROOF-ER FOR STORAGE TANK	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-DWTK5	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR DEWATERING SUMP	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	DEWATERING SUMP	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
MOV-T5A	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
MOV-T5B	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
PIT-T5	PRESSURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
TIT-T5	MULTI-POINT TEMPERATURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
LIT-T5	RADAR TANK GAGING	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
UIT-T5	TANK HUB	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-605	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	VARIOUS
LSHH-T6	LEVEL SWITCH - DISPLACER	1 POSITION LEVEL SWITCH WITH PROOF-ER FOR STORAGE TANK	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-DWTK6	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR DEWATERING SUMP	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	DEWATERING SUMP	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
MOV-T6A	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
MOV-T6B	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
PIT-T6	PRESSURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
TIT-T6	MULTI-POINT TEMPERATURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
LIT-T6	RADAR TANK GAGING	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
UIT-T6	TANK HUB	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-106B	EI-653	M-606	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	VARIOUS
LSHH-T7	LEVEL SWITCH - DISPLACER	1 POSITION LEVEL SWITCH WITH PROOF-ER FOR STORAGE TANK	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-DWTK7	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR DEWATERING SUMP	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	DEWATERING SUMP	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
MOV-T7A	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
MOV-T7B	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
PIT-T7	PRESSURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
TIT-T7	MULTI-POINT TEMPERATURE TRANSMITTER	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
LIT-T7	RADAR TANK GAGING	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	FIELD BUS
UIT-T7	TANK HUB	ATG SYSTEM	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-107B	EI-653	M-607	STORAGE TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	VARIOUS
LSHH-RCT	LEVEL SWITCH - DISPLACER	1 POSITION LEVEL SWITCH WITH PROOF-ER	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	RECLAIM TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
VEEDER ROOT PANEL	LEAK / LEVEL PANEL	LEAK & LEVEL DETECTION SYSTEM	UNCLASSIFIED (INDOOR RATED)	E-404	-	-	PDC	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	INTRINSICALLY SAFE
LIT/TT-RCT	MAGNETOSTRICTIVE LEVEL & TEMP. PROBE ASSEMBLY	LEAK & LEVEL DETECTION SYSTEM	CLASS 1 DIVISION 1 GROUP D, INTRINSICALLY SAFE	E-405	EI-655	M-608	RELCAIM TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	INTRINSICALLY SAFE
LD-RCT	LEAK DETECTION PROBE	LEAK & LEVEL DETECTION SYSTEM	CLASS 1 DIVISION 1 GROUP D, INTRINSICALLY SAFE	E-405	EI-655	M-608	RECLAIM TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	INTRINSICALLY SAFE
LD-14	HYDROCARBON DETECTION PROBE	LEAK & LEVEL DETECTION SYSTEM	CLASS 1 DIVISION 1 GROUP D, INTRINSICALLY SAFE	E-402	EI-657	M-602	RECLAIM TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	INTRINSICALLY SAFE
TIT-TP1	TEMPERATURE TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	MOTOR HOUSING	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
VITX-TP1	VIBRATION TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	MOTOR HOUSING	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
VITY-TP1	VIBRATION TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	MOTOR HOUSING	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
PIT-TP1	PRESSURE TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	MOTOR HOUSING	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
FSTS-TP1	FLOW & TEMPERATURE SWITCH - THERMAL DISPERSION		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	120 VAC RATED DRY-CONTACTS
MOV-RCR	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
MOV-RCS	VALVE WITH ELECTRIC ACTUATOR		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	PIPE	33 52 47	MECH. SUB	MECH. SUB	ELEC. SUB	480 VAC / 3PH.	
MS-RFS1	MOISTURE SWITCH AND WATER DETECTION SYSTEM		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	FILTER VESSEL	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	120 VAC RATED DRY-CONTACTS

INSTRUMENT SCHEDULE

INSTRUMENT TAG NO.	INSTRUMENT TYPE	COMMENTS	HAZARDOUS RATING	LOCATION PLAN	ELEC. RISER PLAN	P&ID	EQUIPMENT / PIPE	SPECIFICATION	PROCURED BY	INSTALLED ON EQUIPMENT BY	WIRED BY	POWER REQ. (VOLTS/PHASE)	ELECTRICAL OUTPUT
MS-RFS2	MOISTURE SWITCH AND WATER DETECTION SYSTEM		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	FILTER VESSEL	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	120 VAC RATED DRY-CONTACTS
DPIT-RFS1	DIFFERENTIAL PRESSURE TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	FILTER VESSEL	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
DPIT-RFS2	DIFFERENTIAL PRESSURE TRANSMITTER		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	FILTER VESSEL	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	4-20 mA
FIT-OP1	FLOW METER - POSITIVE DISPLACEMENT	OFFLOAD METER	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-654	M-608	PIPE	33 52 48	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	-
FIT-OP2	FLOW METER - POSITIVE DISPLACEMENT	OFFLOAD METER	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-654	M-608	PIPE	33 52 48	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	-
FIT-HCTS	FLOW METER - POSITIVE DISPLACEMENT	HCTS METER	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	PIPE	33 52 48	MECH. SUB	MECH. SUB	ELEC. SUB	LOOP POWERED (24 VDC)	-
FS-OP1	FLOW SWITCH - THERMAL DISPERSION		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-654	M-608	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	120 VAC RATED DRY-CONTACTS
FS-OP2	FLOW SWITCH - THERMAL DISPERSION		CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-654	M-608	PIPE	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	120 VAC / 1 PH.	120 VAC RATED DRY-CONTACTS
LSH-SS4	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR SUMP SEPARATOR	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-405	EI-655	M-608	SUMP TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-SS3	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR SUMP SEPARATOR	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-402	N/A	M-602	SUMP TANK	25 30 01	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-OWS.L	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-103	EI-657	M-601	OWS	33 56 41	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-OWS.O	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-103	EI-657	M-601	OWS	33 56 41	MECH. SUB	MECH. SUB	ELEC. SUB	-	120 VAC RATED DRY-CONTACTS
LSH-14	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR CONTAINMENT SUMP PANEL	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-402 / E-606	EI-657	M-602	CONTAINMENT SUMP	33 56 41	ELEC. SUB	ELEC. SUB	ELEC. SUB	-	INTRINSICALLY SAFE
LSL-14	LEVEL SWITCH - FLOAT	1 POSITION LEVEL SWITCH FOR CONTAINMENT SUMP PANEL	CLASS 1 DIVISION 1 GROUP D, EXPLOSION PROOF	E-402 / E-606	EI-657	M-602	CONTAINMENT SUMP	33 56 41	ELEC. SUB	ELEC. SUB	ELEC. SUB	-	INTRINSICALLY SAFE

SECTION 25 50 01 - FACILITY CONTROLS FOR FUEL SYSTEMS

PART I - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies all aviation fuel system controls and associated equipment. Coordinate all work with Division 33, as well as the equipment suppliers and the Division 26 installers. Provide all completion services specified, including final system performance verification, to ensure the system functions as specified. Refer to Divisions 25, 26 and 33 for interfacing controls and instrumentation with mechanical equipment and systems.

B. Conform to Division 26 Sections for raceways, cables and conductors, terminations and splices, boxes, cabinets, supports, hangers, seals, and other applicable requirements governing the installation of the electrical components of the controls systems.

C. Coordinate system controls installation and requirements with Section 25 30 01 - Instrumentation for Fuel Systems and Section 25 90 01 - Control Sequences for Fuel Systems and Division 33 for valves, motors, and fuel system accessories.

D. The control system design in the Drawings and Specifications is intended to be schematic in nature and indicates basic performance criteria and basic wiring requirements. The level of detail is intended to be utilized by the Subcontractor for accurate bidding and communicates the sequence of operations for the fuel system controls. The Subcontractor shall provide exact, detailed, complete point-to-point control system design for approval before assembly and fabrication. The Subcontractor shall provide detailed model numbers of all components used within the control panels.

E. All control and instrumentation work, control panels, programmable logic controllers, and fuel system commissioning shall be accomplished by or under the direction of a qualified systems integrator.

F. Provide modifications to existing level and EFSO panel per contract drawings.

G. Provide modifications to existing PLC cabinet per contract drawings.

H. Provide all services hereinafter, including final system performance verification, to ensure the system functions as specified.

I. All control and instrumentation work, control enclosures, programmable logic controllers, and fuel system commissioning shall be accomplished by or under the direction of a qualified controls system integrator.

J. Relist/Recertify existing control enclosures, as needed, to maintain UL 508A listing.

1. Level and EFSO Panel
2. PLC Cabinet

1.03 QUALITY ASSURANCE:

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. D1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.
2. National Electrical Manufacturers Association (NEMA):
   a. ICS - Industrial Controls and Systems.
3. National Electrical Code (NEC).

4. Underwriters Laboratories (UL).

B. Systems Integrator's Qualifications:
   1. Shall have a complete engineering, sales, installation, and service organization with successful experience in the design, system application programming, installation and start-up of at least five similar systems and at least one aircraft hydrant fueling system, aircraft refueler loading system and aviation fuel storage facility.
   2. Normally involved in the design and manufacture of specially constructed control panels.
   3. Capability of assembling all components and completing all internal wiring.
   4. Capability to complete design of the total control panel and provide shop drawings to the Engineer prior to accomplishing assembly.
   5. Capability to simulate each function required and complete all testing specified.
   6. Capability of supporting the start-up and checkout of the total system and provide field service as required at the Electrical Enclosure factory checkout and installation site.
   7. UL certified for the construction of control panels.

C. Regulatory Requirements: Control wiring shall comply with all applicable codes and regulations.

D. Factory Tests:
   1. Factory testing in accordance with applicable standards shall be conducted on all equipment.
   2. System operational tests simulating actual system operation shall be performed on all system components and subassemblies to assure that all devices and systems are in proper working order prior to shipment.
   3. Furnish factory test reports to the Contractor at time of shipment.

1.04 SUBMITTALS:

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Compliance submittals shall indicate clearly the exact size, model number, specification compliance and other pertinent items to be furnished.

C. All as-built submittals and any submittals, that have yet to be submitted, shall be submitted for approval within 60 days of project completion.

D. Product Data: Complete manufacturers descriptions, catalog data and information:
   1. Control panel, including weight and center-of-gravity in Seismic Zones.
   2. Control panel nameplates.
   3. Electrical system components.
   4. Programmable logic controller (processor, communications modules, I/O boards, power supplies, etc.)
   5. Report Printer
   6. Operator interface software.
   7. Isolators.
   8. Uninterruptible power supplies.
   9. Protocol Converters.
   10. Switches.
   11. Data Logger (Chart Recorder) with 10-inch Screen.
   12. HMI displays/workspaces (See below Article 2.07 in this Section for additional submittal requirements).

E. Drawings:
   1. General outline, fabrication and erection drawings.
   2. Detailed equipment installation drawings.
   3. Arrangement drawings for control panel.
   4. "As shipped" and "Conforming to construction records" copies (minimum of three) of relay logic both when panel is shipped and at the completion of the project.

F. Diagrams:
   1. Complete internal wiring diagrams.
   2. External connection diagrams showing terminal block designations for all field wiring connections.
   3. Schematic diagrams.

G. Reports and lists:
   1. Bills of Material.
   2. Nameplate list.
   3. Factory test reports.
   4. Startup and Commissioning plan and checklist: Submit plan 15 working days prior to commissioning activities.

H. Experience record(s) of manufacturer's field engineer(s) assigned to this project, noting fuel system integration experience.

I. Operations and Maintenance Manuals:
   1. Submit in accordance with Division 01.
   2. Manuals shall include the following:
      a. Operation and maintenance instructions for all items.
      b. Recommended spare parts list for a normal two-year operating period.
      c. Copy of all internal and external wiring and connection diagrams.
      d. Bill of Materials indicating the equipment as installed.
      e. As-built cause and effect matrix.
      f. Written copy of all programming with complete labeling/commenting and color copies of graphic screens.

J. HMI Sample Screens – Submit samples of Fuel System HMI screens to Contractor and Owner for review and approval.
   1. Submit alarm lists and alarm descriptions for approval.

K. Programming:
   1. Color copies of proposed graphic screens.
   2. Provide two copies of all working programs (i.e., PLC logic, personal computer) on read-only CDs as well as a printed program listing. CD shall be dated and labeled.
   3. Code shall be annotated with complete labeling. Provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, shall be identified as to the type of device, i.e., limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments shall be provided for input and output rungs. The programmer shall also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.
   4. PDF of programming code “As shipped” and “Conforming to construction records”.
   5. Documentation of original licenses for PLC programming software, HMI software and workstation software.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Provide products in sizes and capacities indicated, and as required by the application, conforming to manufacturers' standard materials and components as published in their product information.

B. All furnished products, including those listed in the Specifications by manufacturer and model number, will be acceptable subject to meeting all contract requirements.

2.02 CONTROL PANELS:

A. The following control panels shall be shop fabricated for the Fuel Facility:
   1. No new panels anticipated.

B. Custom Fabricated Design Requirements:
   1. NEMA 12 cabinet with continuous hinged cover with three-point latch and backplane for all indoor cabinets.
   2. All welded construction with welds ground smooth.
   3. All field cutouts shall be ground smooth and covered with edge guard.
   4. Provide ventilation fans, grilles, thermostats, heaters, etc. as recommended for project location.
   5. Pentair / Hoffman Engineering Company (Hoffman), Rittal Corporation or approved equal.
      a. Enclosure shall be maintained between 0°C and 30°C.

2.03 CONTROL PANEL NAMEPLATES:

A. Fabricate from laminated phenolic sheeting with white core and black satin finish melamine overlay.

B. Thickness: 1/16 inch nominal.

C. Attached to panels and instruments with contact cement or double-faced tape.

D. Edges beveled to expose white core on perimeter.

E. Minimum 1/4-inch legend lettering engraved through overlay to expose core.

F. Nameplates for all devices mounted on or inside control console. Nameplates shall be black phenolic with white engraving, minimum (1/4-inch lettering) unless otherwise indicated.

2.04 ELECTRICAL SYSTEM:

A. Wiring:
   1. Provide all wiring necessary for equipment specified for installation, including internal wiring for all spare equipment and all future connections as indicated.
   2. Terminal blocks for all external connections except shielded cables.
   3. NEC type THHN/MTW wire, rated 90ºC at 600V.
   4. Wire shall be sized for load being served.
   5. Wiring shall be color coded consistently within panel.
   6. Wire Markers:
      a. Hot-stamped tube-type, Brady Ty-grip, Electrovert slip-on Type Z, or Floy Tag FT200C wire markers sized for snug fit for wire size.
      b. Identify both ends of panel interior wiring with the same unique wire number.

c. Wire numbers shall be as indicated in the circuit schedules or assigned by manufacturer where specific designations are not indicated by Contract Documents.

7. Wiring Methods:
   a. Main groups of wires routed in plastic nonflammable wiring duct with removable covers.
   b. Smaller groups of wire cabled and secured with nylon cable clamps and ties or plastic spiral wraps.
   c. Instrument dc signal wiring shall be routed in separate ducts or groups from ac power and control wiring.
   d. Intrinsically safe wiring shall be separated from other wiring systems per NEC requirements.
   e. Wire with no splices and all connections made on equipment studs or terminal blocks. Except for shielded cables, route all wiring requiring field connections to terminal blocks conveniently grouped to receive the external cables. Wire all spare contacts on switches and relays to terminal blocks.
   f. Provide extra flexible hinge wire in areas subject to flexing such as hinged panels, doors, etc.
   g. Equipment Connections:
      (1) All connections made with insulated locking spade lug terminals except where devices specified are available only with solder-type terminals.
   h. Solder Connections: Soldering iron used not to exceed 100 W.
   i. Provide terminal blocks for all external connections.
   j. Provide copper internal ground bus. Connect all internal grounds required to the bus. Provide lug connection for No. 4 AWG connection to the ground grid.

B. Terminal Blocks:
   1. Terminal blocks shall be as follows:
      a. All field wiring terminals:
         (1) Provide terminal marking strips.
         (2) Spacing: Provide the following clear space between terminal strips for field cabling.
            (a) Minimum: 6 inches.
            (b) Normal: 1.5 inch for each 15 terminals high.
         (3) Modular type.
         (4) Weidmuller type SAKC 6, Square-D GR-6, Phoenix Contact, or approved equal.
   2. Mount terminal blocks in one or more rows on the mounting panel within the board. Provide means for cleating external control cables which enter from the bottom. Location of terminal blocks and arrangements of external circuits shall be subject to approval by the Engineer.
   3. Identify each terminal on each block by stamping or marking the terminal designation permanently on the block.
   4. Provide a minimum of 25% extra terminals with identification as required by the Engineer.

C. Circuit Breakers:
   1. Trip rating as indicated or recommended by manufacturer of equipment being protected.

2. Provide UL listed, DIN rail mounted or similar miniature circuit breakers as indicated. Breakers shall be thermal magnetic and have 10,000 amp interrupting rating.
3. General Electric, Square D or approved equal.

D. Push Buttons and Selector Switches:
1. Heavy-duty oil tight units with contacts rated 10A continuous at 120Vac.
2. Provide the number of contacts and contact development as indicated.
3. Push buttons shall have a black operator.
4. Square D, Allen-Bradley or approved equal.

E. General-Purpose Control Relays:
1. Potter & Brumfield Series KRP, Struthers-Dunn Series 219, or approved equal.
2. Provide with coil voltage as indicated with a neon coil energization indicator on 120Vac coils.
3. Number of contacts required rated at 10-A at 120Vac.
4. Provide plug-in relay with matching socket.

F. Exhaust Fans:
1. 100 cfm, 3,000 rpm, 120V, 1 phase, 60 hertz.
2. Provide with finger guard.
3. Mount at uniform spacings in top of enclosure and set back sufficiently to clear strip fluorescent fixture.
4. Maximum speech interference level of 38 decibels.
5. Dayton Company, Hoffman Engineering Company or approved equal.

G. DC Power Supplies:
1. Provide two DC power supplies and means to select between the two for redundancy.
2. Units shall operate from a 120Vac, 60-hertz power source.
3. Outputs shall be +24Vdc.
4. Output current rating of units shall be 150% of the maximum requirements of the control system furnished, 5-amp minimum.
5. Units must contain line isolation transformers and full-wave silicon rectifier bridges. Rectifier circuits shall be filtered and regulated to provide a ripple less than +1% and a regulation of +1%.
6. Lambda, Power One or approved equal.

H. Convenience Outlets:
1. Where identified within contract drawings, receptacles shall be 120Vac, 20-A duplex, NEMA 5-20R.

2.05 PROGRAMMABLE LOGIC CONTROLLER (PLC):

A. General:
1. PLC shall consist of a solid state control system which has user programmable memory for storage of instruction to implement specific functions.
2. PLC shall be designed to operate over conditions specified in Section 26 05 10 Basic Electrical Requirements.
3. All external connection points shall be capable of withstanding the ANSI Surge Withstand Capability (SWC) test per ANSI C37.90a.
4. PLC shall operate without damage per IEEE Standard 281.

B. All equipment must be currently manufactured and shall not be scheduled for loss of support and/or obsolescence for four years from time of startup.

C. Processor:
   1. Modular processor shall have user-programmable memory with provisions to prevent unauthorized changes.
   2. Provide random access memory (RAM) of sufficient size to accommodate system operation.
   3. RAM shall be battery-backed with an external alarm contact to indicate when battery needs to be changed.
   4. Processor shall continuously perform diagnostics analysis with a predetermined failure mode in the event of a fault. External contact output shall indicate a processor fault.
   5. Processor shall include a real time clock and calendar accessible by the user program.

D. Communication Module:
   1. All PLC communications protocol and hardware shall be compatible with the operator interface software specified.
   2. Communications modules shall be provided as indicated on the drawings.

E. Input/Output (I/O) System:
   1. I/O shall be isolated and current limited or fused from the internal circuitry so that shorting, grounding or opening the circuit at the receiving or transmitting equipment will not affect control system performance.
   2. Output contacts shall be rated 120Vac, 2 amps, 24Vdc, 0.5 amps as indicated.
   3. Each I/O module shall have a mechanical keying scheme to prevent improper module placement in the rack.
   4. Provide sufficient capacity to meet required number of I/O points of each type with 20% spares.
   5. Provide surge suppression kits for solid-state devices.
   6. External programmer for the I/O boards shall be supplied to the project at its completion.

F. Power Supplies:
   1. The PLCs shall operate from 120 VAC, 60 hertz, single-phase power.
   2. Provide all equipment required to transform and/or condition the power for use by the PLC.
   3. Power supply shall be sized for a maximum capacity of PLC rack.

G. System Redundancy:
   1. Provide redundant processors as indicated on the drawings.
   2. Provide spare power supplies of each type and mount in cabinet.

2.06 DATA LOGGER (CHART RECORDER):

A. Provide chart recorder for the Fuel Facility Control Panel (PLC-1). Chart recorder shall be capable of displaying hydrant system flow and pressure from PT-MAIN1, and PT-MAIN2. Mount Chart recorder on the face of the Fuel System Control Panel and on the Manual/EFSO backplane side as indicated on the Drawings.

B. Operating Voltage: 24Vdc.

C. Inputs: 4-20mA analog inputs.

D. Output: (1) alarm relay.

E. LED Touch Screen.

F. Capable of powering loop powered devices.

G. Chart Recorder shall be used for manual operation and remain in operation during a PLC failure or removal of the PLC backplane. Chart recorder shall continue to display flow rate and pressure data from PT-MAIN1 AND PT-MAIN2
H. Capable of calculations to totalize flow.
I. Screen Size: 10" (minimum)
J. Acceptable Manufacturer: Endress+Hauser, Horner OCS, or approved equal.

2.07 HUMAN MACHINE INTERFACE:

A. Main System Displays: Provide new HMI/operator displays. Main system displays are in the Control Room of the Administration Building.
   1. The following, at a minimum, shall be identified on display driven screens.
      a. Tank Levels and Alarms.
      b. Valve positions.
      c. Flow switch status.
      d. Temperature switch status.
      e. Motor run status.
      f. Hydrant System Pressure
      g. Hydrant System Totalize Flow Rate.
      h. Hydrant System Bypass Flow Rate.
      i. Emergency Fuel Shutoff Status.
   2. The following shall be identified on the HMI screens. The information below may be menu driven and viewed by clicking on a device rather than display driven.
      a. Motor run time and trending. Motor runtime shall be tracked for lifetime of motor from the in-service date.
      b. Pump vibration trending over a 24-hour and 1-week period.
      c. Flow rate trending over a 24-hour, 1 week, and 1-month period.
      d. Pressure trending over a 24- hour, 1 week, and 1-month period.
      e. Pump speed (an RPM approximation based on the 4-20mA signal is acceptable).
      f. Pump power/current draw (for all VFD motors only).
      g. Pump fault status (for all VFD motors only).
   3. Alarms: Alarms shall visually and audibly annunciate on the Main System Display to alert the Operator. At a minimum, include the following alarms. Alarms shall be specific and identify the associated tank, pump, or valve associated with the alarm. Refer to Section 25 90 01 Sequence of Operations for complete description of alarms.
      a. Tank High-High Level
      b. Tank High Level
      c. Maximum Working Level
      d. Minimum Working Level
      e. Tank Low Level
      f. Valve Fail to Open
      g. Valve Fail to Close
      h. Motor fail to run
      i. Motor high temperature
      j. Fuel High Temperature
      k. No Flow Alarm
      l. Filter/Separator Moisture Alarm

m. Filter/Separator Differential Pressure Alarm.
n. Pump Vibration Alarm
o. Oil Water Separator and Lift Station Alarms.
p. Emergency Fuel Shutoff (identify Fuel Facility or Airside Alarm)
q. Communication Failure
r. UPS Status/Power Supply Failure, Battery Low
s. Processor Failure

4. Provide operator system displays in new operations building. Systems displays shall consist of the following:
   a. Provide one operator workstation (Fuel System HMI) with (2) 24" monitors located in the Control Room. Final monitor size and quantity to be coordinated with Operator.
   b. Provide one operator workstation (EFSO system HMI) with (2) 24" monitors located in the Control Room. Final monitor size and quantity to be coordinated with Operator
   c. HMI shall be display driven rather than menu driven.

B. GRAPHICS/WORKSPACE INTERFACES:
   1. The workspace displays and graphics submitted to the Contractor for approval shall include all:
      a. Menus
      b. Submenus
      c. Graphic tables, charts, gauges, and similar
      d. Alarms

C. OPERATOR INTERFACE HARDWARE:
   1. Microsoft: Windows based, 32/64-bit, color-graphic supervisory operator interface software package to facilitate monitoring of the fueling system operation, and selection of the systems operating parameters. Provide licensed copy of development version.
   2. Operator interface software shall have real-time interface software to perform the following:
      a. Collect and write a real-time data to one or more relational databases.
      b. Read data stored in relational database and write it back to the process database.
      c. Delete data in relational database tables.
      d. Backup data and commands in the event of network communications failure.
      e. Automatically restore data to the relational database once network communications are reestablished.
   3. Acceptable Manufacturers: Manufacturers shall be Intellution, Wonderware, Factory Talk or approved equal. Version shall be the latest available.

2.08 OPERATOR INTERFACE PANELS/REMOTE SYSTEM DISPLAYS (OIT):

A. System Displays: Provide system displays on the Fuel System Control Panel. System display shall be mounted to the face of the Fuel System Control Panel and on the PLC backplate side of the enclosure as indicated on the drawings.
B. HMI shall be display driven rather than menu driven. The display shall include, but is not limited to the following:
   1. Alarm Display

a. Tank Level Status/Alarms
b. Hydrant Pump Status
c. EFSO Status
d. PLC Status
e. Communication Failure
f. UPS Status/Power Supply Failure
g. Battery Low
h. Processor Failure

C. OPERATOR INTERFACE HARDWARE:
1. Microsoft: Windows based, 32/64-bit, color-graphic supervisory operator interface software package to facilitate monitoring of the fueling system operation, and selection of the systems operating parameters. Provide licensed copy of development version.
2. Operator interface software shall have real-time interface software to perform the following:
a. Collect and write a real-time data to one or more relational databases.
b. Read data stored in relational database and write it back to the process database.
c. Delete data in relational database tables.
d. Backup data and commands in the event of network communications failure.
e. Automatically restore data to the relational database once network communications are reestablished.
3. Acceptable Manufacturers: Manufacturers shall be Intellution, Wonderware, Citect SCADA, Factory Talk or approved equal. Version shall be the latest available.

2.09 PROTOCOL CONVERTER:

A. General: Provide industrial device servers for communication with fuel system instrumentation and control panels. Configurable serial interface shall support RS-485 with terminal block or RJ45 connections. Server shall provide connection to 10Base-T/100Base-TX Ethernet networks. Serial and Ethernet ports shall be isolated.
B. Manufacturer: Manufacturer shall be Phoenix Contact, Lantronix, B_B SmartWorx, or approved equal.

2.10 COPPER ETHERNET SWITCH:

A. General: Provide ethernet switches as indicated on the drawings. Switches shall be 10/100/1000 Mbps Ethernet switch with RJ-45and SFP fiber connections. Switch shall auto detect transmission speeds of connected network devices and adjust its throughput accordingly.
B. Manufacturer: Manufacturer shall be Allen Bradley, N-Tron, Phoenix Contact, Red Lion, or approved equal.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. General: Provide cabinet-mounted uninterruptible power supplies (UPS) for Fuel System Control Panel. Cabinet shall contain separate UPS for PLC and Tank Level/EFSO Panel. UPS shall be supplied with mounting kit to provide backup for PLC.
B. Input power supply and output power supply shall be as indicated on the drawings.
C. Provide leak-proof, maintenance-free sealed lithium-ion battery with suspended electrolyte.

D. Provide with alarm contacts and connect to PLC input to notify Operator via HMI notification when on battery and low battery notification. Minimum audible alarms shall include alarm when on battery, and low battery alarm.
E. Back-up run time shall be 15 minutes minimum.
F. UL Listed.
G. Operation Temperature: 0°C to 40°C
H. Manufacturer's Field Services: Furnish the services of an experienced field service engineer for two days (minimum) on-site for start-up, troubleshooting, and instructing the Operator. In addition, furnish one day and one trip for training.
I. Acceptable Manufacturers: Manufacturers shall be Eaton, Phoenix Contact or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install all system components in accordance with manufacturer's recommendations, roughing-in drawings and details on drawings. Provide all necessary interconnections, services, and adjustments necessary for a complete and operable system. All electrical work shall be in accordance with the NEC and all applicable location regulations, NECA's "Standard of Installation", and Subcontract.
B. All setpoints shall be documented during as-built submittal.

3.02 INSPECTION:

A. Inspect work in progress in accordance with project documents.

3.03 DELIVERY AND STORAGE OF EQUIPMENT AND MATERIALS:

A. Provide factory shipping cartons for each piece of equipment and control device. Store equipment and materials inside and protected from weather.

3.04 ELECTRIC WIRING:

A. All electric wiring shall be in accordance with ANSI/NFPA 70 and DIVISION 26. Install control wiring, without splices between terminal points, color-coded, and numbered on both ends. Install in neat, workmanlike manner, with all conductors securely fastened.

3.05 START-UP AND TESTING:

A. General: Provide personnel at project site to provide technical assistance for start-up and testing. Start-up and testing shall be coordinated with the Contractor and overall fueling system start-up test. Prior to this test, all connections shall have been made between the control panel, the personal computer, the motor control center, and all field devices as appropriate for phasing. In addition, wiring shall have been checked for continuity and short circuits. Adjust set point values and timing values as required to provide a functional fuel control system. Calibrate equipment and verify all site communications are operational before the system is placed on-line.
B. Construction Phasing Support: Provide programming and on-site start-up support to support sequencing of systems.

C. Start-Up: Perform all testing, calibrating, adjusting, and final field tests. Provide a cross-check of each control point within the system by making a comparison between the control command and the field controlled device. Verify that all systems are operable from local controls in the specified failure mode upon PLC failure or loss of power.
   1. At a minimum, startup and testing shall include the following:
      a. Loop checks
      b. Operational verification of each input and output at the PLC and HMI. Each input and output shall be tested by operating the field device to verify appropriate action/status receipt by the PLC.
      c. Verification that all systems are communicating properly, and statuses are visible on the HMI and Operator Interface.
      d. Verification that Variable Frequency Drives are communicating with the Fuel System Controls and appropriate information is being sent or received (run status, run speed, fault status, warnings, hand off auto mode, etc).
      e. Testing of all tank modes.
      f. Testing of all pumps and motor operated valves to verify commands and statuses are received or transmitted.
      g. Testing of all EFSO pushbuttons to verify pump shutdown. as identified in 25 90 01 Controls Sequence for Fuel Systems.
      h. Testing of systems during automatic transfer to and from Generator power to ensure proper operation of control system after transfer is complete.
      i. Printing of sample reports.

D. Final System Acceptance Test: The system acceptance test shall be conducted on the complete operational system to demonstrate that it is functioning properly in accordance with all requirements of this specification. The correct operation of all controlled points shall be demonstrated, as well as the operation of all software. The Contractor shall witness all tests.

E. Operational System Test: After final system acceptance testing but prior to the Subcontractors warranty period beginning, an operational test period shall be conducted of not less than 30 consecutive days, 24 hours per day. In the event of system failure during the operational system test, the defective equipment shall be repaired by the Subcontractor and a written report provided explaining in detail the nature of each failure, corrective action taken, and recommendations of any follow-on action. The operational system test shall continue on a day-to-day basis until 30 consecutive days have passed without failure to any part of the system. Parts and labor to correct any failed device shall be provided by the Subcontractor.

3.06 TRAINING:

A. Upon completion of the system start-up a competent technician shall hold a training class for the instruction of user personnel in the operation and maintenance of the system. Provide both classroom-type theory instruction and hands-on instruction using operating equipment provided. The period of instruction shall be a minimum of two 8-hour working days on different shifts to ensure all personnel receive the necessary training. The Owner and Engineer shall receive written notice a minimum of 14 days prior to the date of the scheduled classes.

B. Furnish a written lesson plan and training schedule for approval at least 60 days prior to instructing operating and maintenance personnel. The training program shall provide:
   1. Troubleshooting of the system.

3.07 SERVICE CONTRACT:

A. Provide one-year service contract with guaranteed on-site response time of 24 hours or less to a call for service. Provide both software and hardware maintenance of programmable logic controller and associated control devices.

END OF SECTION 25 50 01

SECTION 25 90 01 - CONTROLS SEQUENCES FOR FUEL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY OF WORK:

A. This Section describes the sequence of operations for the equipment associated with or affected by this project. Operational descriptions are provided for the following systems:
   1. Pipeline Receipt
   2. Pipeline Receipt Filtration
   3. Truck Offload and Filtration
   4. Aboveground Storage Tanks
   5. Aboveground Storage Tank Gauging and Overfill Prevention
   6. Tank Transfer
   7. Hydrant System
   8. Hydrant Cart Test Stand
   9. Reclaim Tank
   10. Sump/Separators
   11. Offspec Tank
   12. Diesel Generator
   13. Oil/Water Separator
   14. Emergency Fuel Shutoff (EFSO) - Fuel Storage Facility
   15. Emergency Fuel Shutoff (EFSO) - Pipeline
   16. Uninterruptible Power Supply (UPS)

1.03 REFERENCES

A. API 2350 – Overfill Protection for Storage Tanks in Petroleum Facilities

PART 2 - PRODUCTS - Not Used.

PART 3 - EXECUTION

3.01 PIPELINE RECEIPT:

A. General: The Fuel Storage Facility is served by one Jet A pipelines – Kinder Morgan Pipeline.
   1. The facility is fully-attended 24 hours per day, 7 days per week. Assigned personnel are on the premises continuously during the entire receipt of product from pipeline. Personnel on site have the ability to terminate the receipt for the tank of concern.
   2. Controls and instrumentation for the Pipeline equipment are maintained and operated by the Pipeline company.
   3. The Fuel Storage Facility PLC and instrumentation shall communicate with the Pipeline PLC by hard-wired connections via input/output cards in the control systems. No protocol interface devices are required for communication between the Fuel Storage Facility and Pipeline equipment.

B. PLC Ready-to-Receive Permissive to Pipeline: The Fuel Storage Facility PLC output shall energize an interposing relay to indicate facility infrastructure is prepared to receive product.

The Pipeline PLCs input shall monitor the status of this relay contact. The output signal shall be disabled if any of the following occur:

1. No tank is in Receipt Mode.
2. Receipt Mode tank MOVs flow path is not open.
3. Receipt Mode tank at High High ATG level (Automatic Tank Gauge).
4. Receipt Mode tank at High High LS level (Level Switch).
5. Mechanically operated valves not verified in position via prompt on HMI.
6. Fuel Storage Facility EFSO condition is detected.

C. Pipeline Flow Signal from Pipeline: The Pipeline PLC shall send one output signal to an interposing relay to indicate "Flow" and "No Flow" conditions based on flowrate through Pipeline meter. A Fuel Storage Facility PLC input shall monitor the status of this relay contact and indicate flow condition on HMI.

D. Alarms: Level alarms for the receipt tanks and EFSO alarms are described in ABOVEGROUND STORAGE TANK GAUGING AND OVERFILL PROTECTION and EMERGENCY FUEL SHUTOFF SYSTEM (EFSO) of this specification.

3.02 PIPELINE RECEIPT FILTRATION:

A. General: Jet A receipt from pipeline is filtered prior to storage. Jet A incoming from pipeline flows through a filter train which consists of a pre-filter, clay treater, and filter/separator.

B. The following controls and instrumentation are installed at the receipt filtration:

1. Moisture Switches: A moisture switch is installed on each of the filter/separators. The PLC monitors the moisture switches and indicates on the HMI when the water in the filter has risen to high level.
2. Differential Pressure Indicating Transmitters: A differential pressure indicating transmitter is installed on each of the filter vessels. The PLC monitors the differential pressure and indicates on the HMI when the pressure differential has risen above a set level. High pressure differential shall signal an audible and visual alarm at the HMI.

C. Each filter vessel inlet can be isolated through use of manually operated valves.

D. Fuel Storage Facility Alarms: Alarms for the following shall be annunciated on the HMI and exterior alarm horn as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared through a product level change in the vessel.

1. High water detection at receipt filter/separator (audible at HMI).
2. High pressure differential at any receipt filter vessel (audible at HMI).

3.03 TRUCK OFFLOAD AND FILTRATION:

A. General: Two over-the road transport truck offloading positions are available at the Fuel Storage Facility. Each offload position contains an offloading pump that is piped to a meter and manifolded to the reclaim filter vessels. During normal operations, a dedicated Receipt Filter/Separator is provided for offload filtration.

B. Each truck offload pump train consists of the following controls:

1. Hand-Off-Auto (HOA) selector switch on the face of the starter in the PDC to select between Hand and Auto operation.
2. Start/Stop pushbutton local to the pump. This pushbutton is used when the HOA switch is in the Hand and Auto position.
3. Run status shall be monitored by the PLC and status displayed on the HMI.

4. A flow switch is installed on each pump train and monitored by time delay relays and the PLC. Flow status shall be indicated on the HMI.
5. A flow meter is installed on each pump train. For offloading operations, the meter will be recorded manually by the Operator. The HMI shall display the flow rate.

C. Offloading operations shall be performed manually by the Operator.
1. Operator needs to command MOV-RCR open on the HMI. Confirm valve is open prior to starting the pump.
2. Operator needs to establish a receipt tank and confirm flow path. This includes aligning of manual valves in the field.
3. To start the offload process, the Operator will press start on the start/stop pushbutton local to the pump.
4. Remote Operation: If the HOA switch is in the Auto position, the unload pump shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied.
   a. PLC Permissives:
      (1) Tank High-High level detected on the receipt tank selected (High High from either ATG or LS).
      (2) Flow switch detects a loss of flow scenario. (Set at 20 seconds. Adjustable at HMI by Administrator Level).
   b. EFSO at the Fuel Storage Facility.
   c. Flow switch detects a no flow scenario (Set at 45 seconds. Adjustable within the motor starter).
   d. High temperature in motor windings (MWTS).
5. Hand Operation: If the HOA switch is in the Hand position, the unload pump shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied.
   a. EFSO at the Fuel Storage Facility.
   b. Flow switch detects a no flow scenario. (Set at 45 seconds. Adjustable within the motor starter).
   c. High temperature in motor windings (MWTS).
6. The offload process can be stopped at any point by pressing stop on the start/stop pushbutton local to the pump.

D. The truck offload positions are equipped with a filter/separator. The filter separator is equipped with the following controls:
1. Filter/Separator Moisture Detection Unit: A moisture detection unit is installed on the filter/separator sump. The moisture detection is monitored by the PLC. In the event of a moisture detection, an alarm shall annunciate on the HMI. The moisture detection panel will de-energize the water slug control valve.
2. Filter Separator (water slug) Control Valve: A flow control valve is installed on the outlet of the filter/separator. The valve is hydraulically controlled to regulate flow.
3. Differential Pressure Indicating Transmitter: A differential pressure indicating transmitter is installed on the filter/separator. The PLC monitors the differential pressure indicating transmitter and indicates on the HMI when the pressure differential has risen above a set level.
4. A mechanical flow meter is also installed on the flow control valve. This flow meter is completely mechanical in nature and assists operators in logging differential pressure.

E. Fuel Storage Facility Alarms: Alarms for the following shall be annunciated on the HMI and exterior alarm horn as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared.
   1. Flow switch detects a no flow scenario at offload pump. (audible at HMI)
   2. High water detection at receipt filter/separator (audible at HMI).
   3. Differential pressure limit detected at reclaim filter/separators (audible at HMI).

3.04 ABOVEGROUND STORAGE TANKS:

A. General: Three new vertical Jet A aboveground storage tanks (ASTs), Tank 5, Tank 6, and Tank 7, are located at the Fuel Storage Facility. Jet A is received through pipeline or truck offload and filtered prior to entering storage tanks.
B. The 8" receipt (fill) line is the source of fuel for each tank.
C. Two (2) motor operated valves (MOVs) are associated with each AST to control flow of fuel into and out of each tank. Hardwired controls, connected to the PLC, shall be used to control and monitor each actuator. The valves are opened and closed depending on the tank mode chosen on the HMI. The position of the valve (open or closed) and a summary alarm for any on-board diagnostics are monitored by the PLC and reported on the HMI. The following MOVs are associated with each of the tanks.
   1. Tank Receipt Inlet Valve (8" Fill): Controls flow of fuel into the Tank.
   2. Tank Issue Outlet Valve (20" Suction): Controls flow of fuel out of the Tank.
D. Tank Fill Header Valves: Controls fill from the receipt line.
E. Tank low suction valves at the tank skin are manual valves and shall be normally closed unless the Operator is performing a tank-to-tank transfer or recirculation.
F. Settle Mode: The Operator can select Settle mode on the HMI and the PLC shall automatically sequence inlet and issue outlet valves to close. Settle mode shall be shown by tank, receipt inlet valve, and issue outlet valve color changes on the HMI. With the tank status in Settle mode, a timer shall begin for the associated tank, counting up from zero for Operator awareness. If Operator attempts to change the tank status prior to timer reaching the minimum tank Settle time (minimum tank Settle time requirement to be coordinated with Operator), then a prompt shall notify the Operator of this situation on the HMI. Operator may bypass this prompt in order to change modes, if necessary. The timer shall end and be reset to zero seconds if the tank status mode changes.
G. Receipt Mode: The Operator can select the Receipt mode on the HMI and the PLC shall automatically sequence the inlet valve to open and the issue outlet valve to close. When a tank is selected for Receipt mode, a notification shall appear on the HMI that the tank is ready for receipt after valve position indicates open/closed conditions as indicated above. The Receipt mode shall be shown by tank and valve color change on the HMI.
H. Issue Mode: The Operator can select Issue mode on the HMI and the PLC shall automatically sequence inlet valve to close and the issue outlet valve to open. Issue mode shall be shown by tank, tank receipt inlet, and tank receipt outlet valve color changes on the HMI. One tank must be in Issue mode for any hydrant pump to operate in automatic mode.
I. Transfer Mode: The Operator can select Transfer mode on the HMI and the PLC shall automatically sequence both the inlet and issue outlet valves to close. The low suction valve at the tank skin must be manually opened by the Operator. When a tank is selected for Transfer mode a notification shall appear on the HMI that transfer of fuel is a manual process and manual valves must be opened/closed. Transfer of Jet A in a tank is accomplished by the

Transfer Pump (TP-2). The pump must be manually started by the Operator at local start/stop pushbutton. Transfer mode shall be shown by tank, receipt inlet valve and issue outlet valve color changes on the HMI.

J. Out-of-Service Mode: The Operator can select Out-of-Service mode on the HMI if it is necessary for both tank receipt inlet and tank issue outlet valves to be closed for maintenance. In the situation where either inlet or outlet valve is closed and the Operator attempts to select the valve to open at the HMI, a warning/verification sub-display shall appear to confirm intended selection. This condition must be acknowledged before the PLC allows the closed valve to open.

3.05 ABOVEGROUND STORAGE TANK GAUGING AND OVERFILL PROTECTION:

A. General: The new Jet A aboveground storage tanks (ASTs) are equipped with a Rosemount tank gauging system with temperature and density compensation.

B. The equipment shall provide accurate inventory measurement and indicate tank inventory in real time on the HMI. The following controls and instrumentation are installed at the ASTs:

1. Automatic Tank Gauging: Measure product level, product temperature, product weight, and indicate tank inventory in real time on the HMI. The tank gauging system calculates density based on the level, temperature and pressure input signals.
    a. Level Transmitter: Product level data in each AST is measured by a radar gauge, monitored by an automatic tank gauging interface controller and indicated on the HMI.
    b. Temperature Transmitter: Multi spot, averaging temperature array in each AST is measured by a temperature transmitter and relayed into the automatic tank gauging system via the level transmitter.
    c. Pressure Transmitter: A pressure transmitter is located at the base of the tank providing the head pressure and relayed into the automatic tank gauging system via the Tank hub.
    d. Field Display & Interface (Tank Hub): A remote level & temperature display is located at the bottom of each tank stairs.
2. Level Switches: High-High level switches are installed for each AST to provide redundant alarm capability in the event of automatic tank gauging system failure. This switch is hard-wired to the level and EFSO panel. The level and EFSO panel provides an input to the PLC for alarming on the HMI.

C. Product Levels of Concern (LOCs): The ATG System and high-high level switch shall provide level alarms or alerts based on the ATG data and condition of level switches. The following levels shall be identified: (see Appendix Table 9 – Tank Levels of Concern)

1. Critical High Tank Level: The highest level in the tank that product can reach without detrimental impacts (i.e., product overflow or tank damage) or reduced level as determined by Operator.
2. High-High Tank Level: An emergency action alarm level set sufficiently below the critical high level to enable termination of receipt before the critical high level is reached.
    a. Level Switch High-High Alarm (LSHH): A separately hard-wired level switch, connected to the level and EFSO panel. The level and EFSO panel provides an input to the PLC. Both the level and EFSO panel as well as the PLC shall alarm if the fluid height in the tank exceeds the Level Switch High-High level. This status shall be monitored by the PLC and displayed on the HMI. This condition shuts down all offloading pumps in Auto operation and causes the PLC to command

close the Receipt Inlet Valve on the associated Tank. Product level change is required prior to resuming pipeline receipt, tank to tank transfer, or offloading operations for a tank in High-High. The Operator shall have capability to resuming pipeline receipt or offloading operations with a different tank that is not in the High-High Alarm state.

b. ATG High-High Alarm (ATG HH): The ATG System shall recognize when the fluid height in the tank exceeds the ATG High-High level. This status shall be monitored by the PLC and displayed on the HMI. The PLC shall alarm if the fluid height in the tank exceeds the ATG High-High level. This condition shuts down all offloading pumps in Auto operation and causes the PLC to command close the Receipt Inlet Valve on the associated Tank. Product level change is required prior to resuming pipeline receipt, tank to tank transfer, or offloading operations for a tank in High-High. The Operator shall have capability to resume pipeline receipt or offloading operations with a different tank that is not in the High-High Alarm state.

3. Maximum Working Level (ATG MAX): An operational level that is the highest product level to which the tank may routinely be filled during normal operations.
   a. Maximum Working Level shall be noted on the HMI as a fixed point.
   b. Max Working Alert: The ATG System shall recognize when the max working level fluid height has been reached. This status shall be monitored by the PLC and displayed on the HMI.
4. Minimum Working Tank Level (ATG MIN): An operational level that is the lowest product level to which the tank may routinely be emptied during normal operations.
   a. ATG Minimum Working shall be noted on the HMI as a fixed point.
   b. Minimum Working Level Alert: The ATG System shall recognize when the min working level fluid height has been reached. This status shall be monitored by the PLC and displayed on the HMI.
5. Low-Low Tank Level (ATG LL): An alarm level set below the minimum working level to prevent air from entering pumping system.
   a. ATG Low-Low Alarm: The ATG System shall alarm if the fluid height in the tank decreases beneath the ATG LL level. This status shall be monitored by the PLC and displayed on the HMI. This condition shuts down all hydrant pumps and causes the PLC to command close the Tank Issue Outlet valve. The product level is required to be raised prior to resuming Tank Issue or Transfer operations. The Operator shall have the ability to resume Tank Issue or Transfer operations with a different tank that is not in the ATG LL Alarm state.
6. Fuel Storage Facility Alarms: Alarms for the following shall be annunciated on the HMI and exterior alarm horn as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared through a product level change in the tank.
   a. Level Switch High-High level (audible at HMI, exterior alarm horn).
   b. ATG High-High level (audible at HMI, exterior alarm horn).
   c. ATG Max Working level (audible at HMI).
   d. ATG Min Working level (audible at HMI).
   e. ATG Low-Low level (audible at HMI, exterior alarm horn).

3.06 TANK TO TANK TRANSFER:

A. General: The tank-to-tank transfer function shall be Operator controlled. Product may be transferred between tanks with the Transfer Pump (TP-2). When Transfer mode is selected on the HMI, a prompt at the HMI shall warn the Operator that the valves along the flow path are manually operated and shall be field verified.

B. Tank to Tank Transfer shall be performed manually by the Operator.
   1. The Operator will open/close valves, so flow is directed from the desired tank, to the Transfer Pump (TP-2) and to the appropriate tank via the receipt manifold.
   2. The Operator will select Transfer mode from the HMI (see Aboveground Storage Tanks for more information).
   3. The Operator will select the Transfer Pump (TP-2) to operate in "Transfer Mode" from the HMI. This shall close the PLC permissive contact as long as all other PLC permissives have been satisfied.
   4. The Transfer Pump is controlled by a Hand-Off-Auto (HOA) switch on the face of the motor starter and a start/stop pushbutton local to the pump. During typical operations, the HOA will be in the Auto position.
   5. To start the pumps, the Operator will press the start on the start/stop pushbutton local to the pump.
   6. The pump can be stopped at any time by pressing stop on the start/stop pushbutton local to the pump.
   7. Note the pump can also be started by placing the HOA switch in Hand position. This shall bypass the PLC permissives.

C. Remote Operation: If the HOA is in the Auto position, the Transfer Pump (TP-2) shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied.
   1. PLC Permissives:
      a. Tank High-High level on Transfer to Tank.
      b. Flow switch in loss of flow condition. (Set at 20 seconds. Adjustable at HMI by administrator Level).
   2. EFSO at Fuel Storage Facility.
   3. Flow switch in no flow condition. (Set at 45 seconds. Adjustable within the motor starter).
   4. Motor winding temperature above normal level (MWTS).

D. Hand Operation: If the HOA is in the Hand position, the Transfer Pump (TP-2) shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied.
   1. EFSO at Fuel Storage Facility.
   2. Flow switch in no flow condition. (Set at 45 seconds. Adjustable within the motor starter).
   3. Motor winding temperature above normal level (MWTS).

3.07 HYDRANT SYSTEM:

A. General: System is capable of up to seven (7) hydrant pumps and filter/separator trains issuing fuel from one suction header supplied from the Jet A storage tanks. Five (5) pump trains are designed to be connected to one discharge header with space for two (2) additional filter/separator trains reserved for future use. Each header is connected to piping that distributes fuel to the hydrant main line. This main line distributes fuel to the airside hydrant pits. The hydrant pumps will be controlled by variable frequency drives (VFDs). In addition, a

recirculation/bypass line is installed from the 20-inch pump discharge header to the 20-inch suction line to maintain the hydrant pumps' minimum continuous stable flow (MCSF).

B. The following controls and instrumentation are necessary for issuing fuel from the hydrant pumps and filter/separators:
   1. Motor winding thermostats (MWTS): A thermostat is provided in each motor winding of the into-hydrant pump motors. The thermostats shall be monitored by an auxiliary contact on each VFD. Should an into-hydrant pump motor fail due to its motor winding thermostats, the motor's associated VFD shall report the specific cause of the into-hydrant pump failure to the PLC and the HMI shall display "Pump Failure due to Motor Winding Thermostat." Failed into-hydrant fuel pumps shall be de-energized by the pumps' associated VFDs and shall be reenabled or enabled by the VFDs once the temperature switches no longer detect high motor winding temperature. Alarms shall be resolved once acknowledged through the HMI and the associated into-hydrant fuel pump shall be reenabled or enabled until the setpoint are exceeded again.
   2. Vibration Indicating Transmitters: Two vibration transmitters are installed on each hydrant pump's bearing housing on two different axes. The transmitters are monitored by the PLC and logged. Two (2) alarms setpoints shall be provided for the vibrations transmitters; one shall be a warning alarm setpoint and the other higher setpoint shall disable the respective hydrant pump until the alarm(s) are acknowledged on the HMI. Alarms shall be resolved once acknowledged through the HMI and the associated hydrant pump shall be reenabled or enabled until the setpoints are exceeded again. The vibration transmitters' setpoints shall be established by the pump manufacturer's service engineer during startup and commissioning. Subcontractor shall provide Owner and Engineer with empirical values obtained for each pump when the hydrant pumps are running at full speed and at their design flow rate.
   3. Temperature Indicating Transmitters: A temperature transmitter is provided on each hydrant pump's bearing housing. The temperature transmitters shall be monitored by the PLC and alarms annunciated on the HMI. Two (2) alarms setpoints shall be provided for the temperature transmitters; one shall be a warning alarm setpoint temperature and the other higher setpoint temperature shall disable the respective hydrant pump until the alarm(s) are acknowledged on the HMI. Alarms shall be resolved once the associated pump's bearing temperature is below the setpoint temperature and is acknowledged through the HMI; the associated hydrant pump shall be reenabled or enabled until the setpoint is exceeded again. The temperature transmitters' setpoints shall be established during startup and commissioning by the pump manufacturer's service engineer.
   4. Start/Stop and Hand-Off-Auto functions shall be performed through the VFD controls on the VFDs. The "HAND" function shall energize its associated into-hydrant fuel pump provided the permissive signal exists. In the event of a PLC failure and loss of permissive signal, each individual VFD shall include a manual override/bypass that restore the permissive signals to the into-hydrant fuel pumps to permit manual operation of the Start/Stop and HOA on the VFDs regardless of the status of the PLC.
   5. Filter/Separator Moisture Detection Switch: A moisture detection switch is installed on each of the filter/separator sumps. The status of the moisture detection switch shall be monitored by the PLC and the VFD. Status shall also be wired directly in the circuit to the solenoid valves on filter/separators' water slug valves. In the event of a moisture detection, an alarm shall annunciate on the HMI displaying in which filter/separator

moisture is detected. In addition, the pump shall be shut down and water slug valve closed through the motor circuit controls.

6. Solenoid Controlled Water Slug/Flow Control Valves: A water slug/flow control valve is located on the outlet of each filter/separator in each pump train. The valve solenoid is hard-wired to its corresponding pump train motor starter and shall only be energized (allowing valve to open with pressure) when the motor is running. The solenoid shall de-energize, forcing valve closure, when the associated hydrant pump is not running or the water detection probe is activated.
7. Filter/Separator Differential Pressure Indicating Transmitter: Each of the hydrant filter/separators are equipped with a differential pressure indicating transmitter. The status of the differential pressure indicating transmitter shall be monitored by the PLC. In the event of differential pressure detected above pressure setpoint, an alarm shall annunciate on the HMI displaying which filter/separator differential pressure exceeded the setpoint.
8. Flow & Fuel Temperature Switch:
    a. A flow and fuel temperature switch are located on each pump discharge line. The flow status of this device is wired to the VFD. The VFD provides an output signal to be monitored by the PLC. Flow status shall be indicated on the HMI. The VFD and PLC each receive a digital signal representing flow status. The "flow" relay energized by the flow switch is normally an open contact. Both the PLC and the VFD shall include an adjustable delay after a pump is started before the pump is failed due to no flow conditions. The VFDs' programmed and adjustable delay shall exceed the PLC's adjustable delay to prevent the VFDs from failing pumps before the PLC fails the in "AUTO Control." The VFDs' programmed and adjustable delay shall protect the hydrant fuel pumps from a no flow condition when the VFDs are operated in "HAND." Should a hydrant pump fail due to a no flow condition, its associated VFD shall report the specific cause of the hydrant pump failure to the PLC and the HMI shall display "Pump Failure due to No Flow Condition."
    b. A flow and fuel temperature switch are located on each pump discharge line. The fuel temperature status of this device is wired to the VFD. The VFD provides an output signal to be monitored by the PLC. Fuel temperature status shall be indicated on the HMI. The VFD and PLC each receive a digital signal representing fuel temperature status. The fuel temperature relay, energized by the fuel temperature switch, is normally an open contact. Both the PLC and the VFD shall include an adjustable delay after a high fuel temperature is detected before the pump is failed due to high fuel temperatures. The VFDs' programmed and adjustable delay shall exceed the PLC's adjustable delay to prevent the VFDs from failing pumps before the PLC fails the pump in "AUTO" Control. The VFDs' programmed and adjustable delay shall protect the hydrant fuel pumps from a high fuel temperature condition when the VFDs are operated in "HAND." Should a hydrant pump fail due to high fuel temperature, its associated VFD shall report the specific cause of the hydrant pump failure to the PLC and the HMI shall display "Pump Failure due to High Fuel Temperature."
9. Recirculation Control Valve (RCV): A digital control valve shall be installed on the recirculation/bypass line. RCV shall include adjustable rate of open and rate of closure speed control pilot valves to dampen the modulation speed of the RCV to prevent

hysteresis and tune the operation of the RCV. The RCV shall include a manual ball valves in the pilot tubing and backpressure pilot valves that may be enabled manually using the ball valves in the event the VFDs are operated in "HAND."

10. Orifice Plate Flow Indicating Transmitter for Hydrant Flow: A compact conditioning orifice plate flow transmitter is installed on each pump train. Hydrant Flow shall be defined as the combined flow sensed by each pump train transmitter minus the recirculation/bypass flow sensed by the recirculation ultrasonic flow meter. The measured flowrate of the meters shall be monitored and data logged by the PLC. The HMI shall display the instantaneous flowrate measured by the flow meters. The HMI shall also display the total volume of fuel issued to the hydrant system in gallons, which shall be resettable to zero by the Operator through the HMI. The flow transmitter shall be used to determine a 'no flow' condition in each pump train. The set point and delay timer used to determine a 'no flow' condition shall be individually adjustable on the HMI during commissioning. When a 'no flow' condition occurs, the corresponding VFD for that pump train motor shall be told to stop. Placing the VFD in hand mode, among other things, will allow a 'no flow' condition to be bypassed. Should a hydrant pump fail due to a 'no flow' condition, the HMI shall display "Pump Failure due to No Flow Condition".
11. Ultrasonic Flow Transmitter for Recirculation/Bypass Flow: An inline ultrasonic type flow meter shall be installed in the recirculation/bypass line. Bypass Flow shall be defined as the flow sensed by the Bypass Flow Transmitter. The Bypass Flow Transmitter shall also be used to verify that the RCV in the bypass line has closed. The HMI shall display the instantaneous flowrate measured by the flow meter. The measured flowrate of the ultrasonic meter shall be monitored and data logged by the PLC. The HMI shall display the instantaneous flowrate measured by the flowmeter. The HMI shall also display the total volume of fuel returned to storage in gallons, which shall be resettable to zero by the Operator through the HMI.

C. The following controls and instrumentation are necessary at the hydrant discharge manifolds for issuing fuel from the hydrant pumps and filter/separators to the hydrant system piping (airside):
   1. Pressure Transmitter: Two pressure transmitters are installed in a small pipe segment connecting the discharge header. The pressure transmitters shall be monitored by the PLC with system pressure indicated on the HMI and logged. The PLC shall monitor both transmitters values and utilize the higher pressure to control pump speed (the pressure transmitter reporting the higher pressure shall be used in the sequence of operation and the pressure transmitter reporting the lower pressure shall be excluded from the sequence of operation). The pressure transmitters shall also report pressure to the data logger on the PLC Panel unless otherwise indicated elsewhere, which shall display the instantaneous pressure on the discharge manifolds. Data recorder shall display the pressure sensed by both pressure transmitters (PT-1 and PT-2).
   2. Suction, Pressure Indicating Transmitter: One pressure transmitter shall be provided and connect to the pump suction header with instrument valve. The pressure transmitter shall be monitored by the PLC with system pressure sensed by both pressure transmitter displayed on the HMI. The PLC shall monitor both pressure transmitter values and use the lower pressure to control (the pressure transmitter reporting the lower pressure shall be used in the sequence of operation and the pressure transmitter reporting the higher pressure shall be excluded from the sequence of operation).

3. Data Logger: Screen shall be a minimum of 10-inch with color touch screen. The data logger programming shall include a screen that displays hydrant system totalized flow rate and the pressures sensed by each of the two pressure transmitters (PT-1 and PT-2). The data logger screed shall be visible and legible from the HOA switches on the VFDs.

D. When a Tank is selected for Issue, Receipt, or Settle mode, the MOVs shall be automatically sequenced when the mode is selected.

E. When more than one pump is operating and energized, the pumps shall operate at the same frequency (Hz) and speed when enabled and energized by the PLC in "AUTO." Note the speed of the pumps might be adjusted as part of commissioning through their VFDs such that the pump curves of the pumps match at a given or constant input speed from the PLC.

F. During startup and commissioning, the VFD manufacturer or its representative shall program the VFDs (not the PLC) with maximum and minimum pump speeds. The initial maximum pump speed shall be 56Hz and the pump minimum speed shall be 44Hz.

G. When running, the pump's speed shall modulate to maintain the system pressure at an initial setpoint pressures (adjustable), as sensed by the pressure transmitters PT-1 and PT-2 on the aboveground hydrant discharge manifold. The PLC shall poll the two hydrant system pressure transmitters and the pressure transmitter reporting the higher pressure shall be used to control the pump's or pumps' speed, unless one of the pressure transmitters is disabled manually through the HMI. The PLC shall modulate the pump's speed to maintain a setpoint pressure of 150 psig (adjustable).

H. The pressure transmitter on the suction of the into-hydrant pump shall enable/determine which setpoints in below Table "A" start and stop lag pumps. In general, when the suction pressure as sensed by the enabled pressure transmitter (PT-3) is below -5.0 psig, the lower flow rate setpoints (last two rows) for starting and stopping into-hydrant pumps shall be enabled to reduce the into-hydrant fuel pumps' net positive suction head require (NSPHr) and to prevent cavitation. When the suction pressure is below -5.0 psig as sensed by the enabled pressure transmitter, a low pressure warning alarm shall occur and remain until the alarm is acknowledged, reset, and resolved by the fuel system operator. When the suction pressure as sensed by the enabled pressure transmitter (PT-3) is at or above -5.0 psig, the higher flow rate setpoints for starting and stopping into-hydrant pumps shall automatically be enabled. A lower suction pressure setpoint of -7.5 psig shall de-energize the into-hydrant pumps until the alarm is acknowledge and manually reset through the HMI.

I. The initial set points herein shall be adjustable and may be adjusted through startup and commissioning.

J. In general, the RCV shall modulate to maintain the following defined setpoint flowrates in the recirculation line defined in Table "B." The RCVs shall include a manual ball valves in the pilot tubing and backpressure pilot valves that may be enabled manually using the ball valves in the event the VFDs are operated in "HAND" should the PLC fail.

K. General Pump Control:
1. Each pump shall be controlled by a VFD.
2. Each VFD shall have a HOA switch mounted to the face of the enclosure.
3. When the VFD is in the "HAND" position, the pump shall be energized and operate at 60 Hz (adjustable through the VFD).
4. When the VFD is in the "OFF" position, the pump shall be de-energized.
5. When the VFD is in the "AUTO" position, the pump shall be enabled by the PLC.

L. AUTO Control (Normal Operation):
1. The VFD shall be in the "AUTO" position.

2. Permissives to energize the hydrant fuel pumps:
   a. A tank suction nozzle valve shall be open and the tank's level associated with the open tank suction nozzle shall be above low-low level.
   b. At least one hydrant pump shall be enabled through the PLC and its HOA switch on the VFD shall be in the "AUTO" position.
3. Idle Condition:
   a. When the system pressure is above 140 psig (adjustable) as sensed by the enabled pressure transmitter (PT-1 and/or PT-2) after the lead pump has been de-energized, the lag pumps shall be idle and remain de-energized.
4. Lead Pump "START" Condition:
   a. With the above permissives met, the lead pump shall energize, and its speed shall increase to maintain the system setpoint pressure when the system setpoint pressure decreases below 120 psig for three consecutive seconds (adjustable) as sensed by the enabled pressure transmitter. The enabled pressure transmitter shall be whichever pressure transmitter is reporting the higher pressure when polled. Once initially energized, the lead pump's speed shall modulate to maintain the system setpoint pressure. The RCV shall modulate independent of system pressure to maintain the setpoint flowrate as defined below in Article 3.07 L. 10 and in Table "B."
5. Lag pump "START" conditions (Increased demand):
   a. When the above permissives are met and the lead pump/motor is operating at 59 Hz or above the flow rate defined in Table "A" for five consecutive seconds (adjustable), the lag pump/motor shall energize. As the lag pump motor energizes the lead pump/motor's speed shall decrease until the lead and lag pump/motors synchronize at the same speed. The lead and lag pumps speed shall modulate at the same speed, to maintain the system set pressure defined above as sensed by the pressure transmitters (PT-1 and/or PT-2).
   b. The above sequence shall be repeated for energizing more than two pumps, where the running pump/motors are operating above the flow rate defined in Table "A" or operating at or above 59 Hz for five consecutive seconds (adjustable). When required, an additional lag pump shall energize and increase in speed to seek to synchronize while the previously energized and synchronized pump modulate at the same speed to maintain the system setpoint pressure as defined above and as sensed by the pressure transmitters (PT-1 and PT-2). Once all operating pumps are synchronized at the same speed, the speed of all operating pumps shall modulate, at the same speed, to maintain the system setpoint pressure. The enabled RCV shall modulate independently as defined below in Article 3.07 L. 10 and Table "B".
6. Lead and Lag Pump Turndown (decrease in speed) when demand decreases:
   a. When the system demand decreases, maintain multiple pumps until all running pumps are operating at a flow rate below the set point shown in Table "A". The pumps shall continue to operate below the prescribed set point for two consecutive minutes before de-energizing a lag pump. Only one lag pump shall be deenergized at a time at two-minute intervals. The enabled RCV shall continue to modulate independently as defined below in Article 3.07 L. 10 and Table "B".
7. Lag Pump stop condition:
   a. Lag pump/motor shall de-energize when the flow rate totalized is less than the flow rate set point in the last row of Table "A" for two consecutive minutes. When a lag

pump/motor is de-energized, the pump(s) continuing to operate shall remain synchronized and modulate, at the same speed, to maintain the system setpoint pressure. The enabled RCV shall continue to modulate independently as defined below in Article 3.07 L. 10 and Table “B”.

TABLE "A"				
LAG PUMP NUMBER	2	3	4	5
WHEN TOTALIZED FLOW RATE IS ABOVE THE SET POINT FOR 5 SECONDS: START LAG PUMP (GPM)	1200	2400	3600	4800
WHEN TOTALIZED FLOW RATE IS BELOW SET POINT FOR 2 MINUTES: DE-ENERGIZE PUMP	1000	2000	3000	4000

8. When only the lead pump is energized, the enabled RCV shall modulate to maintain a minimum totalized flowrate (flowrate to the hydrant system plus recirculation flow) of 800 gpm (adjustable). The minimum continuous stable flow (MCSF) for the hydrant fuel pump is estimated to be 800 gpm per pump and this setpoint might be adjusted during startup and commissioning. When only the lead pump is energized and the hydrant flowrate is above 800 GPM (adjustable), the enabled RCV shall be closed and there shall be no flow through the recirculation line. The following Table “B” establishes initial setpoints for the recirculation line flowrate relative to the number of hydrant fuel pumps operating and totalized flowrate.

TABLE "B"		
FIRST CONDITION	SECOND CONDITION	SET POINT IF FIRST AND SECOND CONDITIONS ARE TRUE
NUMBER OF PUMPS ENERGIZED	HYDRANT FLOWRATE IS LESS THAN OR EQUAL TO	RCV MODULATES TO MAINTAN TOTALIZED FLOWRATE
1	800 GPM	= (800 GPM - Hydrant Flowrate)
2	1,600 GPM	= (1,600 GPM - Hydrant Flowrate)
3	2,400 GPM	= (2,400 GPM - Hydrant Flowrate)

9. De-energizing lead pump:

a. When the flow rate to the hydrant system is less than 100 gpm (adjustable) for more than two consecutive minutes, the digital solenoid valves (normally open and normally closed solenoid valves) of the enabled RCV shall both be deenergized to command the RCV to close. When the flowrate sensed in the recirculation line by the flow meter associated with the enabled RCV is less than 10 gpm (adjustable), the lead pump shall be deenergized.

10. Recirculation/Bypass Control Valve (RCV):
    a. Digital Control Valve Mode: When only the lead pump is energized, the RCV shall modulate to maintain a minimum totalized flow rate (flow to hydrant system plus bypass flow) of 800 gpm (adjustable). The previous Table "B" establishes initial set points for the bypass line flow rate relative to the number of pumps operating and totalized flow rate.
11. Backpressure Mode: The RCV shall operate in backpressure mode during the lead pump stop condition described above. PLC shall sequence/alternate lead pump such that lead pump rotates every time a pump/motor is de-energized (first on-first off).
12. Should pumps be locked out for maintenance or failed due to PLC controls during a period of high demand, a message shall appear on HMI indicating "Too few pumps available to start another pump." when additional pumps are requested to run to support a higher desired flowrate and no pumps are available.
13. Multiple hydrant pumps shall not start simultaneously. A minimum of 15 seconds (adjustable) shall elapse after pump run status has been confirmed and flow transmitter status has indicated system is flowing, prior to attempting to start an additional hydrant pump due to demand. Should a hydrant fuel pump fail to due to its associated flow transmitter not detecting flow in 15 seconds, the pump failure shall be resettable by the Operator through HMI to reenable the failed pump.
14. Once started, a hydrant pump shall run for a minimum of 300 seconds to allow heating induced in motor windings by motor starting in-rush current to dissipate.
15. Pump run time shall be indicated on HMI and logged.

M. Pump Run Permissives and failures through the PLC and VFDs:
1. The hydrant pumps shall not be allowed to start or shall be de-energized if any of the following PLC permissives are not satisfied or failures occur. All permissives, if not satisfied, and alarms shall be displayed on the HMI along with the specific cause of the alarms or lack of permissives described on the HMI. Note this disabling of the automatic pump start permissive will force pump failures as the motors will fail to run when requested to run.
    a. No tank is ready to issue (all tank issue outlet valves are closed).
    b. Issue Jet A tank at Low-Low level (bypass available via HMI).
    c. Emergency Fuel Shutoff (EFSO).
    d. High water detected in filter/separator sump. Note the water detection is hard wired to the water slug valve through the VFD. Water detection in the sump of a filter/separator shall only disabled the hydrant fuel pump associated with the filter/separator in which water is detected.
    e. Motor winding temperature above normal level (note this is hard-wired into the VFD circuit).
    f. Pump bearing temperature above normal level (TT).
    g. Pump vibration above normal level (VT).
    h. Fluid temperature above normal level in the associated pump train (FSTS).

i. No flow condition in the associated pump train (FSTS)

2. In the event that a permissive is not satisfied, pump shall not be allowed to run until the alarm is acknowledged and reset by the Operator.
3. Pump run permissive alerts shall:
   a. Log in SCADA system.
   b. Display on the HMI.
   c. Sound audible at HMI.

N. In both Automatic and Hand operation, the hydrant pump motor shall be de-energized by:
1. No flow condition in the associated pump train (FSTS)
2. High water detected in filter/separator sump (MS).
3. Fluid temperature above normal level in the associated pump train (FSTS).
4. Motor winding temperature above normal (MWTS)
5. Emergency fuel shutoff situation at Fuel Storage Facility.

O. Pump Status: Pump status shall be indicated by color coding the pump symbols on the HMI. Status shall be indicated by the following color scheme:
1. Green - Pump running.
2. Red - Pump off.
3. Yellow - Pump failure.

P. PLC failure and emergency operation:
1. Should the PLCs fail or automatic control system become inoperable, the backpressure feature of RCVs in the recirculation/bypass line shall be manually enabled and pumps shall be manually operated by placing pumps HOA switches in the hand position. Pumps shall be started and stopped manually depending on demand. Local flowrate and system pressure (PT-1 and PT-2) displays shall be provided on the Data Recorder in the Fuel Control System Panel in the Electrical Room so they are within sight of the VFD for "HAND" operation.

Q. Datalog Trending shall Include:
1. Flow rate as sensed by the following:
   a. FE-HP1
   b. FE-HP2
   c. FE-HP3
   d. FE-HP4
   e. FE-HP5
   f. FE-RCL1
   g. FE-RCL2
2. Pressure as sensed by the following:
   a. PT-1
   b. PT-2
3. Number of hydrant pumps running, run times, and number of pump start/stops
4. Current draw to each hydrant pump motor, as sensed by VFD.
5. Hydrant pump motor speed.
6. Hydrant pump failures (along with cause of failure).
7. Hydrant pump bearing temperature.
8. Hydrant pump vibration (velocity and force).
9. Hydrant Pump/Motor VFD frequency/speed.
10. All data shall be stored, available, retrievable, and exportable (CSV file) for a two-year period.

11. The above data shall be stored at one-minute intervals.

3.08 HYDRANT CART TEST STAND (HCTS):

A. General: A Hydrant Cart Test Stand Pump (TP-1) is available at the fuel storage facility to perform calibration of the hydrant carts and vehicles. Product shall flow from the 20,000-gallon Reclaim Tank, through the test stand, and return to the Reclaim Tank. The pump shall be VFD controlled to regulate flow through the hydrant carts.

B. The following controls and instrumentation are necessary for the test stand pump.

1. Motor winding thermostat (MWTS): A thermostat is installed in each motor. The thermostat shall be monitored by auxiliary contacts on the VFD.
2. Start/Stop and HOA functions shall be performed through a switch mounted to the face of the VFD remote from the HCTS.
3. Start/Stop Switch local to the pump on the.
4. Flow & Fuel Temperature Switch:
   a. A flow and fuel temperature switch is located on the pump discharge line. The flow status of this device is wired to the VFD. The VFD provides an output signal to be monitored by the PLC. Flow status shall be indicated on the HMI. The VFD and PLC each receive a digital signal representing flow status. The "flow" relay energized by the flow switch is normally an open contact. Both the PLC and the VFD shall include an adjustable delay after a pump is started before the pump is failed due to no flow conditions. The VFDs' programmed and adjustable delay shall exceed the PLC's adjustable delay to prevent the VFDs from failing pumps before the PLC fails the in "AUTO Control." The VFDs' programmed and adjustable delay shall protect the hydrant fuel pumps from a no flow condition when the VFDs are operated in "HAND." Should a hydrant pump fail due to a no flow condition, its associated VFD shall report the specific cause of the hydrant pump failure to the PLC and the HMI shall display "Pump Failure due to No Flow Condition."
   b. A flow and fuel temperature switch is located on the pump discharge line. The fuel temperature status of this device is wired to the VFD. The VFD provides an output signal to be monitored by the PLC. Fuel temperature status shall be indicated on the HMI. The VFD and PLC each receive a digital signal representing fuel temperature status. The fuel temperature relay, energized by the fuel temperature switch, is normally an open contact. Both the PLC and the VFD shall include an adjustable delay after a high fuel temperature is detected before the pump is failed due to high fuel temperatures. The VFDs' programmed and adjustable delay shall exceed the PLC's adjustable delay to prevent the VFDs from failing pumps before the PLC fails the pump in "AUTO" Control. The VFDs' programmed and adjustable delay shall protect the hydrant fuel pumps from a high fuel temperature condition when the VFDs are operated in "HAND." Should a hydrant pump fail due to high fuel temperature, its associated VFD shall report the specific cause of the hydrant pump failure to the PLC and the HMI shall display "Pump Failure due to High Fuel Temperature."
5. Pressure Transmitter: The transmitter is wired directly to the PLC .

C. The start/stop button for the test stand pump shall be used to start the test stand pump.

D. The pump's speed shall modulate to maintain the system pressure at 140 psig (adjustable), as sensed by the pressure transmitter.

E. General Pump Control:
   1. Pump shall be controlled by a VFD.
   2. VFDs shall have a built-in HOA functions via the keypad and shall normally be in "AUTO."
   3. VFDs shall have a HOA switch mounted to the face of the enclosure.
   4. When the VFD is in the "HAND" position, the pump shall be energized and operate at 50Hz.
   5. When the VFD is in the "OFF" position, the pump shall be de-energized.
   6. When the VFD is in the "AUTO" position for normal operation, the pump shall be enabled by the PLC.

F. Pump run time shall be indicated on HMI and logged.

G. AUTO Control Pump Run Permissives: The hydrant cart test stand pump shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied. Note this disabling of the automatic pump start permissive will force pump failures as the motors will not run when requested to run.
   1. PLC Permissives:
      (1) The level in the 20,000-gallon Reclaim Tank must be above low-level.
      (2) If the 20,000-gallon Reclaim Tank is above high-high level, the tank's high level control valve will be closed. A high-high level condition must be resolved manually in order to resume normal HTCS operations. To lower the level in the 20,000-gallon test stand tank below high-high level, fuel must be returned to storage tanks manually. The manual operation will involve opening the manual valve for a flow path to a storage tanks and manually energizing the test stand pump TP-1 using the HOA on a test stand pump's VFD.
      (3) Flow switch in loss of flow condition. (Set at 20 seconds. Adjustable at HMI by administrator Level).
   2. EFSO at Fuel Storage Facility.
   3. Flow switch in no flow condition. (Set at 45 seconds. Adjustable within the VFD).
   4. Motor winding temperature above normal level (note this is hard-wired into the VFD circuit).
   5. If a permissive is not satisfied, pump shall not be allowed to run until the alarm or condition is acknowledged and reset by the fuel system operator.
   6. Pump run permissive alerts shall:
      (1) Be logged in SCADA.
      (2) Display on the HMI.
      (3) Activate an audible alarm at HMI.

H. HAND Control Pump Run Permissives: The hydrant cart test stand pump shall not be allowed to start or shall be de-energized if any of the following permissives are not satisfied. Note this disabling of the automatic pump start permissive will force pump failures as the motors will fail to run when requested to run.
   1. Emergency Fuel Shutoff
   2. Flow Switch
   3. Motor winding temperature above normal level (note this is hard-wired into the VFD circuit).

I. Pump Status: Pump status shall be indicated by color coding the pump symbols on the HMI. Status shall be indicated by the following color scheme:
   1. Green - Pump running.

2. Red - Pump off.
3. Yellow - Pump failure.

3.09 RECLAIM TANK:

A. General: A 20,000-gallon Reclaim Tank is located at the hydrant cart test stand and reclaim area to support calibration of hydrant carts.

B. The Reclaim Tank is filled from the hydrant system via a new 6-inch underground line. Filling the tank is a semiautomatic operation performed by the fuel system operator using the "HCTS Tank Level Alarm Panel."

C. The following controls and instrumentation will be installed on the tank.
   1. Automatic Tank Gauge – A automatic tank level gauge will be installed to measure level in the tank. The level gauge shall have two alarm setpoints. The level gauge shall report levels to the PLC and HMI.
   2. Independent Level Switch for the High-High – A level switch will be installed on the tank and wired to the PLC and report alarm to the HMI.
   3. There is a high-level control valve (hydraulic operated) that when activated prevents the reclaim tank from overfilling (HLCV)

D. The 20,000-gallon Reclaim Tank shall have the following tank operations available from the HMI:
   1. Start and Stop Fill: These operations are used to fill the tank from the new 6-inch hydrant system fill line.
      a. To fill the reclaim tank, operators shall command MOV-RCS to open on the HMI. The motor operated 6-inch, DBB valve on the 6-inch supply line (MOV-RCS)shall open..
      b. Once the reclaim tank reaches the high level setpoint (adjustable) as sensed by the 20,000-gallon Reclaim Tanks level transmitter (Veeder root communicates this to the PLC), the 6-inch motor operated DBB plug valve from the 6-inch supply line (MOV-RCS) shall close.
      c. The 6-inch motor operated DBB plug valve from the 6-inch supply line (MOV-RCS) shall not be allowed to open or shall be automatically closed if the tank has reached the high-high level alarm as sensed by the level transmitter or independent high-high level switch.
   2. Returning Fuel: These operators are used to return fuel from the reclaim tank to bulk storage.
      a. Operator needs to command MOV-RCR open on the HMI. Confirm valve is open prior to starting the transfer pump (TP-1).
      b. Operator needs to establish a receipt tank and confirm flow path. This includes aligning of manual valves in the field.
      c. Offloading operations cannot occur at the same time as the returning fuel operation.
      d. The operator needs to confirm that TP-1 is in Auto mode within the PDC.
      e. The operator needs to enable 'Return to Storage Mode' on the HMI. This will force transfer pump (TP-1) to operate at 56 HZ (constant speed).
         (1) TP-1 shall automatically stop when low low level is reached within the reclaim tank via the Reclaim Tanks level transmitter. (Veeder root communicates this to the PLC)
      f. Once fuel has been returned to bulk storage the operator shall disable 'Return to Storage Mode'. This will return TP-1 to run at adjustable speeds.

E. The Fuel Facility HMI shall provide level alarm conditions based on the following:
   1. High-High Level: The control system shall alarm if the fluid height exceeds the level transmitter or level switch high-high setpoint. Mechanical overfill prevention activates at 90% of the 20,000-gallon reclaim tanks' nominal capacity (non-adjustable). The PLC will also command MOV-RCS to close.
   2. High-Level: The control system shall alarm if the fluid height exceeds the level transmitter setpoint. High level shall be 80% of the 20,000-gallon reclaim tanks' nominal capacity (non-adjustable).
   3. Low Level: The control system shall alarm if the fluid height decreases below the level transmitter and low-level set point of 20% of the 20,000-gallon reclaim tanks' nominal capacity (non-adjustable). Transfer Pump (TP-1) shall be prevented from running on low level.

F. Fuel Storage Facility Alarms: Alarms for the following shall be annunciated on the HMI and exterior alarm horn as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared through a product level change in the tank.
   1. High-High level (audible/visual alarm).
   2. High-level (audible/visual alarm).
   3. Low-level (audible/visual alarm).

3.10 SUMP/SEPARATORS:

A. General: Sump/separators are located around the fuel facility that are used to remove water from storage tanks and filter/separators. The sump/separators have two pumps. One pump is used to pump water to the off-spec tank. One pump is used to pump fuel back into the fuel system or tank. The following sump/separators are in use around the facility.
   1. SS-1: Tank 3, (motors 10 & 11) (to be demolished)
   2. SS-2: Tank 1 & 2, (motors 12 & 13) (to be demolished)
   3. SS-3: Pump Pad (motors 8 & 9)
   4. SS-4: Reclaim Filter/Separators, (motors 19F & 19W)
   5. SS-T5: Tank 5, (motors 5F & 5W)
   6. SS-T6: Tank 6, (motors 6F & 6W)
   7. SS-T7: Tank 7, (motors 7F & 7W)

3.11 OFF-SPEC TANK:

A. General: The Fuel Storage Facility has one existing Off-Spec Tank. The Off-Spec Tank is piped to relief lines and the common sump return line.

B. The following controls and instrumentation are installed at the off-spec tank:
   1. Level Transmitter/Sensor– A level sensor is installed to measure level of product in the tank.
   2. Level Switch – An independent level switch is set at the high level in the tank.
   3. Mechanical level gauge is located on the off-spec tank.

C. The HMI shall provide level alarm conditions based on the following:
   1. High-High Level: The control system shall alarm if the fluid height exceeds the independent level switch setpoint. High-High level setpoint shall be set to 95% of compartment capacity.
   2. High Level: The control system shall alarm if the fluid height exceeds the level sensor setpoint. High level setpoint shall be set to 90% compartment capacity (non-adjustable).

D. Fuel Storage Facility Alarms: Alarms for the following shall be annunciated on the HMI and exterior alarm horn as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared through a product level change in the tank.
   1. High-High level (audible at HMI, exterior alarm horn).
   2. High level (audible at HMI).

3.12 DIESEL GENERATOR:

A. General: A generator is available at the facility for standby backup power during a utility outage. An automatic transfer switch is installed to switch between normal and standby (generator) power. Loss of service from electric utility company shall be sensed by the ATS located in the Electrical Room of the Operations Building. On loss of normal power from the utility, the ATS shall signal the generator to start and switch to standby power when it is available from the generator. The PLC monitors the status of the transfer switch and other generator parameters and displays the statuses on the HMI.

B. Fuel Storage Facility Alarms: Generator alarms for the following shall be annunciated on the HMI, interior and exterior alarm horns as indicated. Alarm acknowledgement on the HMI shall result only in silencing of the audible alarms. The alarm status shall remain visible until the condition is cleared by the device initiating the alarm.
   1. Facility connected to normal power (indication on HMI only).
   2. Facility connected to diesel generator power (interior alarm horn).
   3. Lube oil temperature high (interior and exterior alarm horns).
   4. Lube oil low pressure (interior and exterior alarms horns).
   5. Water jacket temperature high (interior and exterior alarms horns).
   6. Water jacket temperature low (interior and exterior alarms horns).
   7. Fuel level low (interior and exterior alarms horns).
   8. Low coolant level (interior and exterior alarm horns).
   9. Overspeed (interior and exterior alarms horns).
   10. Overcrank (interior and exterior alarm horns).

3.13 OIL/WATER SEPARATOR:

A. General: The Fuel Storage Facility shall have one Oil/Water Separator. The Oil/Water Separator receives drainage from the hydrant pump pad sump pit pump (“yard pump”, P-14). The tank is separated into a sediment chamber, oil water separation chamber, and effluent water chamber.

B. The following controls and instrumentation are necessary for the Oil/Water Separator:
   1. Oil Water Separation Chamber
      a. Dual Level Switch High – A dual high level switch shall be installed to detect high level of oil and high level of liquid in the Separator chamber. Monitored by the PLC.
   2. Hydrant Pump Pad Discriminating Sump Sensor: A hydrocarbon discriminating sump sensor is installed in the hydrant pump pad containment sump.
      a. The sensor shall be set so that an alarm occurs upon detection of hydrocarbons, and the “yard” pump (P-14) shall shut down. The hydrocarbon alarm is monitored by a Veeder root panel and communicated to the PLC.

C. Fuel Storage Facility Alarms: Alarms for the following shall be displayed on the HMI and annunciated on the HMI or interior alarm horn and exterior alarm horn as indicated. Alarm

acknowledgement on the HMI shall result in silencing of the audible alarms only. The alarm status shall remain visible until the condition is cleared by the device initiating the alarm.

1. Level Alarm High (Oil) (audible at HMI)
2. Level Alarm High (Liquid) (audible at HMI)
3. Hydrocarbon detection alarm (audible at HMI, exterior alarm horn)
4.

3.14 EMERGENCY FUEL SHUTOFF (EFSO) – FUEL STORAGE FACILITY:

A. General: An emergency fuel shutoff (EFSO) system shall be provided at the Fuel Storage Facility to stop the flow of fuel.

B. Fuel Storage Facility EFSO: The EFSO system shall consist of fail-safe relays, alarm horn and EFSO pushbuttons located at the EFSO Control Panel.
   1. EFSO stations shall be located around the Fuel Storage Facility storage tank area, hydrant pump pad area, Operations Building, and truck offload and HCTS canopy.
   2. Activation of any Fuel Facility EFSO station shall de-energize pump motors and close Motor Operated valves as indicated in Table 1 of the Appendix. This equipment shall remain inoperable until the EFSO signal has been reset.
   3. Upon activation of an EFSO button, an indication shall be given on the HMI in the operations building to identify an EFSO condition. An audible alarm shall sound on the HMI and exterior alarm horn. The Operator must press the silence pushbutton on the Emergency Fuel Shutoff Control Panel or at the HMI to silence the EFSO alarm.
   4. The EFSO system must be reset manually via keyed switch at the Emergency Fuel Shutoff Control Panel or electronically at the HMI. This reset shall de-energize the alarm indication light and energize the system on-line indication light.
   5. EFSO Bypass Function:
      a. A keyed bypass switch shall be accessible at the Emergency Fuel Shutoff Control Panel.
      b. Remote bypass shall also be available via the HMI
      c. Engaging the bypass switch shall energize the EFSO system in bypass indicator light and the system on-line indicator light.
      d. Bypass mode shall allow the pump motors to start and valves to open independent of EFSO pushbutton station status.

C. Airside EFSO: The airside EFSO system shall consist of pushbuttons monitored by local Programmable Logic Controllers (PLCs). (Note: Airside EFSO system is existing unless otherwise noted)
   1. EFSO stations shall be located at each gate of the Terminals.
   2. Activation of an airside EFSO pushbutton shall signal to Fuel Storage Facility PLC an EFSO condition. Fuel Storage Facility PLC shall shut down all pumps.

3.15 EMERGENCY FUEL SHUTOFF (EFSO) – PIPELINE

A. General: Communication with Pipeline PLCs shall be done with hardwired controls from the Fuel Storage Facility PLC. Fuel Storage Facility EFSO alarms shall remove the ready to receive permissive from the pipeline PLCs. Removal of the ready to receive signal shall indicate to the pipeline that transfer pump shall be shut down. Activation of an Airside EFSO shall not remove the ready to receive signal from the pipeline PLCs.

3.16 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. An uninterruptible power supply is located at the Fuel Storage Facility. Loss of power at the UPS (Utility outage or other cause for outage) shall be sensed by the UPS which is located in the Fuel Facility PLC Cabinet in the PDC. On loss of incoming power to the UPS, the UPS shall automatically switch to battery power for all outgoing power.

B. Fuel Facility Alarms: UPS alarm for the following shall be annunciated on the HMI.The alarm status shall remain visible until the condition is cleared by the device initiating the alarm.

1. UPS Utility Status:
   a. Utility Power Available
   b. Utility Power Unavailable
2. UPS Status:
   a. UPS on Battery
   b. UPS on Utility
3. UPS Battery Voltage:
   a. Battery Voltage Normal
   b. Battery Voltage Low
4. UPS Battery Health Status:
   a. Battery Health Normal
   b. Replace Battery
5. UPS Bypass Status:
   a. UPS not Bypassed
   b. UPS Bypassed/System NOT on UPS
6. UPS Communication Status:
   a. UPS Comm. Normal
   b. UPS Comm. Fault

END OF SECTION 25 90 01

TABLE 1 - PIPELINE RECIEPT PAD	
VALVE	**POSITION**
V-RP-101	NORMALLY OPEN
V-RP-102	NORMALLY OPEN
V-RP-103	NORMALLY CLOSED
V-RP-104	NORMALLY OPEN
V-RP-105	NORMALLY OPEN
V-RP-106	NORMALLY CLOSED
V-RP-107	NORMALLY CLOSED
V-RP-108	NORMALLY CLOSED
V-RP-109	NORMALLY OPEN
V-RP-110	NORMALLY OPEN
V-RP-111	NORMALLY OPEN
V-RP-112	NORMALLY CLOSED
V-RP-113	NORMALLY CLOSED
V-RP-114	NORMALLY OPEN
V-RP-115	NORMALLY CLOSED
V-RP-116	NORMALLY CLOSED
V-RP-117	NORMALLY OPEN

VALVE POSITIONS CAN BE ARRANGED SUCH THAT EITHER PIPELINE PROVIDER OR TANK RECIRCULATION OPERATION CAN USE ANY FILTER TRAIN AND ANY SUPPLY LINE AFTER FILTRATION TO THE TANKS. ALL OPERATIONS HOWEVER CANNOT BE DONE SIMULTANEOUSLY. VALVE POSITIONS SHOWN ARE FOR THE DETERMINED NORMAL OPERATIONS AS DEFINED BELOW:

- ST LOUIS PIPELINE SHALL NORMALLY RUN DOWN FILTER TRAIN AND RECIEPT LINE 1
- BUCKEYE PIPELINE SHALL NORMALLY RUN DOWN FILTER TRAIN AND RECIEPT LINE 2
- TANK RECIRCULATION SHALL NORMALLY RUN DOWN FILTER TRAIN 3 AND RECIRCULATION LINE

TABLE 2- SETTLE MODE		
TANK	**VALVE**	**POSITION**
1	V-TK101 (MOV-T1A)	CLOSED
	V-TK102 (MOV-T1B)	CLOSED
	V-TK103 (MOV-T1C)	CLOSED
	V-TK104 (MOV-T1D)	CLOSED
	V-TK105 (MOV-T1E)	CLOSED
	V-TK106 (MOV-T1F)	CLOSED
2	V-TK201 (MOV-T2A)	CLOSED
	V-TK202 (MOV-T2B)	CLOSED
	V-TK203 (MOV-T2C)	CLOSED
	V-TK204 (MOV-T2D)	CLOSED
	V-TK205 (MOV-T2E)	CLOSED
	V-TK206 (MOV-T2F)	CLOSED
3	V-TK301 (MOV-T3A)	CLOSED
	V-TK302 (MOV-T3B)	CLOSED
	V-TK303 (MOV-T3C)	CLOSED
	V-TK304 (MOV-T3D)	CLOSED
	V-TK305 (MOV-T3E)	CLOSED
	V-TK306 (MOV-T3F)	CLOSED

TABLE 3 - TRUCK OFFLOAD RECEIPT MODE		
TANK	**VALVE**	**POSITION**
1	V-TK101 (MOV-T1A)	OPEN
	V-TK102 (MOV-T1B)	CLOSED
	V-TK103 (MOV-T1C)	CLOSED
	V-TK104 (MOV-T1D)	CLOSED
	V-TK105 (MOV-T1E)	CLOSED
	V-TK106 (MOV-T1F)	OPEN
2	V-TK201 (MOV-T2A)	OPEN
	V-TK202 (MOV-T2B)	CLOSED
	V-TK203 (MOV-T2C)	CLOSED
	V-TK204 (MOV-T2D)	CLOSED
	V-TK205 (MOV-T2E)	CLOSED
	V-TK206 (MOV-T2F)	OPEN
3	V-TK301 (MOV-T3A)	OPEN
	V-TK302 (MOV-T3B)	CLOSED
	V-TK303 (MOV-T3C)	CLOSED
	V-TK304 (MOV-T3D)	CLOSED
	V-TK305 (MOV-T3E)	CLOSED
	V-TK306 (MOV-T3F)	OPEN

TABLE 4 - PIPELINE RECEIPT MODE - LINE 1		
TANK	**VALVE**	**POSITION**
1	V-TK101 (MOV-T1A)	OPEN
	V-TK102 (MOV-T1B)	CLOSED
	V-TK103 (MOV-T1C)	OPEN
	V-TK104 (MOV-T1D)	CLOSED
	V-TK105 (MOV-T1E)	CLOSED
	V-TK106 (MOV-T1F)	CLOSED
2	V-TK201 (MOV-T2A)	OPEN
	V-TK202 (MOV-T2B)	CLOSED
	V-TK203 (MOV-T2C)	OPEN
	V-TK204 (MOV-T2D)	CLOSED
	V-TK205 (MOV-T2E)	CLOSED
	V-TK206 (MOV-T2F)	CLOSED
3	V-TK301 (MOV-T3A)	OPEN
	V-TK302 (MOV-T3B)	CLOSED
	V-TK303 (MOV-T3C)	OPEN
	V-TK304 (MOV-T3D)	CLOSED
	V-TK305 (MOV-T3E)	CLOSED
	V-TK306 (MOV-T3F)	CLOSED

TABLE 5 - PIPELINE RECEIPT MODE - LINE 2		
TANK	**VALVE**	**POSITION**
1	V-TK101 (MOV-T1A)	OPEN
	V-TK102 (MOV-T1B)	CLOSED
	V-TK103 (MOV-T1C)	CLOSED
	V-TK104 (MOV-T1D)	OPEN
	V-TK105 (MOV-T1E)	CLOSED
	V-TK106 (MOV-T1F)	CLOSED
2	V-TK201 (MOV-T2A)	OPEN
	V-TK202 (MOV-T2B)	CLOSED
	V-TK203 (MOV-T2C)	CLOSED
	V-TK204 (MOV-T2D)	OPEN
	V-TK205 (MOV-T2E)	CLOSED
	V-TK206 (MOV-T2F)	CLOSED
3	V-TK301 (MOV-T3A)	OPEN
	V-TK302 (MOV-T3B)	CLOSED
	V-TK303 (MOV-T3C)	CLOSED
	V-TK304 (MOV-T3D)	OPEN
	V-TK305 (MOV-T3E)	CLOSED
	V-TK306 (MOV-T3F)	CLOSED

TABLE 6 - ISSUE MODE		
TANK	**VALVE**	**POSITION**
1	V-TK101 (MOV-T1A)	OPEN
	V-TK102 (MOV-T1B)	OPEN
	V-TK103 (MOV-T1C)	CLOSED
	V-TK104 (MOV-T1D)	CLOSED
	V-TK105 (MOV-T1E)	OPEN
	V-TK106 (MOV-T1F)	CLOSED
2	V-TK201 (MOV-T2A)	OPEN
	V-TK202 (MOV-T2B)	OPEN
	V-TK203 (MOV-T2C)	CLOSED
	V-TK204 (MOV-T2D)	CLOSED
	V-TK205 (MOV-T2E)	OPEN
	V-TK206 (MOV-T2F)	CLOSED
3	V-TK301 (MOV-T3A)	OPEN
	V-TK302 (MOV-T3B)	OPEN
	V-TK303 (MOV-T3C)	CLOSED
	V-TK304 (MOV-T3D)	CLOSED
	V-TK305 (MOV-T3E)	OPEN
	V-TK306 (MOV-T3F)	CLOSED

TABLE 7 - TANK TO TANK AND TANK RECIRCULATION MODE		
TANK	**VALVE**	**POSITION**
FROM TANK #[X]	V-[X]01 (MOV-T[X]A)	CLOSED
	V-[X]02 (MOV-T[X]B)	CLOSED
	V-[X]03 (MOV-T[X]C)	CLOSED
	V-[X]04 (MOV-T[X]D)	CLOSED
	V-[X]05 (MOV-T[X]E)	CLOSED
	V-[X]06 (MOV-T[X]F)	CLOSED
TO TANK #[Y]	V-[Y]01 (MOV-T[Y]A)	OPEN
	V-[Y]02 (MOV-T[Y]B)	CLOSED
	V-[Y]03 (MOV-T[Y]C)	CLOSED
	V-[Y]04 (MOV-T[Y]D)	CLOSED
	V-[Y]05 (MOV-T[Y]E)	CLOSED
	V-[Y]06 (MOV-T[Y]F)	OPEN

TABLE 8 - EMERGENCY FUEL SHUTOFF

EFSO EVENT	ACTION	SHUT OFF HP-1	SHUT OFF HP-2	SHUT OFF HP-3	SHUT OFF HP-4	SHUT OFF HP-5	SHUT OFF OP-1	SHUT OFF OP-2	SHUT OFF TP-1	SHUT OFF TP-2	CLOSE MOV-1A	CLOSE MOV-1B	CLOSE MOV-2A	CLOSE MOV-2B	CLOSE MOV-3A	CLOSE MOV-3B	CLOSE MOV-5A	CLOSE MOV-5B	CLOSE MOV-6A	CLOSE MOV-6B	CLOSE MOV-7A	CLOSE MOV-7B	REMOVE READY TO RECEIPT PERMISSIVE
FUEL STORAGE FACILITY EFSO	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TANK 1 HIGH HIGH LEVEL										X													X
TANK 2 HIGH HIGH LEVEL												X											X
TANK 3 HIGH HIGH LEVEL														X									X
TANK 5 HIGH HIGH LEVEL																	X						X
TANK 6 HIGH HIGH LEVEL																			X				X
TANK 7 HIGH HIGH LEVEL																					X		X
FIRE ALARM ACTIVATED	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 9 - TANK LEVELS OF CONCERN (LOC)			
Tank Level	**TANK 1**	**TANK 2**	**TANK 3**
Critical High	45'-9"	45'-9"	45'-9"
Level Switch High-High	45'-4"	45'-4"	45'-4"
ATG High-High	44'-0"	44'-0"	44'-0"
ATG Maximum Working	42'-0"	42'-0"	42'-0"
ATG Minimum Working	4'-2"	4'-2"	4'-2"
ATG Low-Low	3'-0"	3'-0"	3'-0"

SECTION 26 05 10 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Contract includes, but is not limited to, the following work components:
   1. Furnish and install (including supports) equipment as per the Drawings and Specifications.

1.03 RELATED REQUIREMENTS:

A. Division 31 for excavation for electrical installations within the building boundaries and from building to utility connections.
B. Division 01.

1.04 REFERENCE STANDARDS:

A. National Electrical Contractors Association (NECA).
B. National Electrical Installation Standards (NEIS): Except where the NEIS requirements specifically deviate from specific requirements of the NEC, the NEC shall take precedence.
C. National Fire Protection Association (NFPA):
   1. NFPA - 70 National Electrical Code (NEC).
D. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE C2 National Electrical Safety Code (NESC).

Underwriters Laboratories (UL).

1.05 SUBMITTALS:

A. Submit as specified in Division 01, Contract and Contract Drawings.
B. Refer to each Section of this Division for specific Submittal requirements.
C. Provide Conforming to Construction Records schematic diagrams and wiring diagrams.
D. Provide product data on electrical material and products.
E. Prepare coordination drawings in accordance with Division 01, Contract and Contract Drawings, for equipment rooms, and other congested areas to a scale of 1/4 inch=1 foot-0 inch or larger if required. Detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Drawings shall be prepared on 22 by 34-inch sheets. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
   1. Indicate the proposed locations of major raceway systems, equipment, and materials.
   2. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
   3. Exterior wall and foundation penetrations.
   4. Fire-rated wall and floor penetrations.
   5. Equipment connections and support details.
   6. Sizes and location of required concrete pads and bases.
   7. Support details.

8. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
9. Prepare floor plans, elevations, and appropriate details to indicate penetrations in floors, walls, and ceilings, and their relationship to other penetrations and installations.
10. Coordinate chases, slots, inserts, sleeves, and openings with general construction work.

F. Prepare record documents in accordance with the requirements in Section 01 78 05 - Contract Closeout. In addition to the requirements specified in Division 01, indicate installed conditions for:
1. Major raceway systems, size and location for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; fuse sizes, circuit breaker sizes and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

G. Prepare maintenance manuals in accordance with Section 01 78 05 - Contract Closeout. In addition to the requirements specified in Division 01, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data, tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; lockout/tagout procedures; and summer and winter operating instructions.
3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, reassembly; aligning and adjusting instructions.
4. Servicing instructions, lubrication charts and schedules.
5. "Conforming to Construction Records" schematic and wiring diagrams.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver products to the Project Site properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.07 PROJECT SITE CONDITIONS:

A. Altitude = 50 feet above mean sea level.
B. Maximum Outdoor Ambient Temperature = 89.1ºF.
C. Minimum Outdoor Ambient Temperature = 32.0ºF.
D. Maximum Outdoor Relative Humidity = 100%.
E. Seismic Factors – refer to Structural Drawing S-001.

PART 2 - PRODUCTS

2.01 PRODUCTS:

A. Unless indicated otherwise, all equipment and material shall be new, undamaged and meet the requirements of Underwriters Laboratories, Inc. (UL). Where UL requirements are not applicable, equipment and material shall be identified as such by Subcontractor and approved by Contractor before purchase and installation.

2.02 ELECTRONIC EQUIPMENT COMPLIANCE:

A. Subcontractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

2.03 FINISHES:

A. For equipment: Equipment manufacturer's paint selected to match installed equipment finish.
B. Galvanized surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
B. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. All electrical work and material shall comply with the following requirements:
   1. NFPA 70 - The National Electrical Code (NEC).
   2. OESC – Oregon Electrical Specialty Code (based on the NFPA 70)
   3. IEEE C2, National Electrical Safety Code
   4. NECA National Electrical Installation Standards (NEIS) (all except Table 1 of NECA 1).
   5. Coordinate electrical systems, equipment, and materials installation with other building components. Equipment motor horsepower sizes and kilowatt sizes shown are approximate. If equipment of a different size is furnished by Subcontractor, Subcontractor shall furnish and install the proper support equipment, motor starter, switchgear, feeders, fuses, circuit breaker, disconnect switch, wire, and conduit required for the equipment furnished, at no additional cost to Contractor.
   6. Verify all existing dimensions by field measurements.
   7. Arrange for chases, slots, and openings in other building components during progress of construction to allow for electrical installations.
   8. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
   9. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building. Coordinate concrete pads, bases, roof curbs, and related items.
   10. Coordinate with all other building trades.
   11. Where mounting heights are not specifically detailed, specified, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
   12. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
   13. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements

indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Should coordination requirements conflict with individual system requirements, refer conflict to Contractor in writing.

14. Install systems, materials, and equipment level, plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
15. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
16. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
17. All equipment and materials shall be installed in accordance with NFPA 70 - The National Electrical Code (NEC) and Oregon Electrical Specialty Code (OESC).
18. All equipment conductor termination provisions shall be UL listed for 75ºC conductors.
19. All electrical equipment and installations shall be of adequate strength to withstand, without failure, forces encountered in defined Seismic conditions.
20. Install raceways, cables, wireways, cable trays and busways clear of obstructions and clear of the required working space of equipment.

C. Refer to each section of this Division for specific performance requirements.

3.02 DEMOLITION:

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality at Subcontractors expense.
B. Accessible Work: Remove and properly dispose of exposed electrical equipment and installations, indicated to be demolished, in their entirety.
C. Abandoned Work: Cut and remove buried raceway and wiring indicated to be abandoned in place, 2 inches below surface of adjacent construction. Cap raceways and patch surface to match existing surface finish.
D. See Division 01 for disposal of demolished material from project site.
E. Remove, store, clean, re-install, reconnect and make operational components indicated for relocation.

3.03 CUTTING AND PATCHING:

A. General: Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of the trades involved. In addition to the requirements specified in Division 01, the following requirements apply:
    1. Perform cutting and patching for electrical equipment and materials required to:
        a. Uncover work to provide for installation of ill-timed work.
        b. Remove and replace defective work.
        c. Remove and replace work not conforming to requirements of the Contract Documents.
        d. Remove samples of installed work as specified for testing.
        e. Install equipment and materials in existing structures.
        f. Upon written instructions from Engineer, uncover and restore work to provide for Engineer's observation of concealed work if installed without using the proper specified procedures.

B. For work in existing installations, the Subcontractor shall cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by the new work.
C. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
E. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
F. All penetrations through fire-rated walls, ceilings and floors shall be sealed with a UL listed and FM Global approved sealant system that matches the fire rating of the surface penetrated.
G. All cutting, patching, and repairing shall be subject to the supervision and the approval of Contractor.
H. Repair and re-finish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fire proofing where existing fireproofing has been disturbed. Repair and re-finish materials and other surfaces by skilled mechanics of trades involved.

3.04 FINISHES:

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit degree of damage at each location.
B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
D. Repair damage to Polyvinyl Chloride (PVC) or paint finishes with matching touchup coating recommended by manufacturer.
E. Repair damage to protective coatings in accordance with manufacturer recommendations.

3.05 CLEANING:

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

3.06 PROTECTION:

A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

3.07 CLOSEOUT:

A. Instructions, training, and manufacturer’s service representative:
    1. Provide on-site instructions and training of Owner’s personnel as specified.
    2. Provide on-site services of a manufacturer's authorized service representative as specified.

END OF SECTION 26 05 10

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Wires and cables rated 1000V and less.
   2. Connectors, splices, and terminations rated 1000V and less.

1.03 RELATED REQUIREMENTS

A. Division 01
B. Section 26 05 10 – Basic Electrical Requirements
C. Section 26 05 29 - Hangers And Supports For Electrical Systems.
D. Section 26 05 53 - Identification For Electrical Systems.
E. Section 26 05 33 – Raceways, Boxes, Sleeves, Seals And Fittings For Electrical Systems.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants (the Red Book).
      b. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings (the Gray Book).
   2. International Electrical Testing Association (NETA):
      a. NETA Acceptance Testing Specification - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
   3. National Electrical Manufacturers Association (NEMA):
      a. NEMA WC 26 - Binational Wire and Cable Packaging Standard (EEMAC 201).
      b. NEMA WC 70 - Non-Shielded Power Cable 2,000V or Less for the Distribution of Electrical Energy.
   4. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code.
      b. OESC – Oregon Electrical Specialty Code (Based on NFPA 70)
   5. Underwriters Laboratories Inc. (UL):
      a. UL 44 - Thermoset-Insulated Wires and Cables.
      b. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
      c. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.
      d. UL 83 - Thermoplastic-Insulated Wires and Cables.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Field quality-control test reports.

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. American Insulated Wire Corp.; a Leviton Company.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.
   6. Pyrotenax.
   7. Approved Equal.
B. Copper Conductors: Comply with NEMA WC 70.
C. Conductor Insulation: Comply with NEMA WC 70 for Types XHHW-2.
D. Multiconductor Cable: Comply with NEMA WC 70 for Type TC-ER with or without ground wire as indicated.

2.02 CONNECTORS AND SPLICES:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Thomas & Betts a ABB company
B. Description: Factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated.
C. All connectors and splicing components shall be UL listed.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS:

A. General: Provide wire and cable suitable for the location where installed.
B. Conductors: Minimum conductor size shall be #12 AWG.
C. Conductor Material: Use copper for all sizes.
D. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
E. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

A. Feeders
   1. Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, 600V, single conductors in raceway.
   2. In Cable Tray: Type XHHW-2, 600V, multiconductor with PVC overall jacket.

B. Branch Circuits
   1. Exposed (Indoor/Outdoor): Type XHHW-2, 600V, single or multi-conductor in raceway.
   2. Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, 600V, single or multi-conductor in raceway.
   3. Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, 600V, single or multi-conductor in raceway.
   4. On the output of VFDs: Type XHHW-2, 1000V multiconductor cable with copper tape shield (100% coverage), PVC overall jacket and three concentric ground wires.

C. Class 1 Control Circuits:
   1. Type XHHW-2, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES:

A. General: Install electrical cables, wires, and connectors in compliance with the NEC and OESC.

B. Coordinate cable installation with other Work.

C. Do not pull wire and cable until raceway system is complete. Pull conductors simultaneously where more than one is being installed in same raceway.

D. Conceal cables in finished walls, ceilings, and floors, where noted.

E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

H. Support cables according to Section 26 05 29 - Hangers And Supports For Electrical Systems.

I. Identify and color-code conductors and cables according to Section 26 05 53 - Identification For Electrical Systems.

J. Keep conductor splices to a minimum. All splices shall be made in junction boxes and shall only be used with explicit written approval from Contractor.

K. Provide adequate length of conductors within electrical enclosures and neatly train the conductors to terminal points. Circuits with conductors larger than No. 10 AWG shall be bundled together inside of enclosures. Make terminations so there are no bare conductors visible at the terminal.

L. Insulation Color Coding for Phase Identification:
   1. Color code 600V (1000V for VFD cable) insulated, service entrance, feeder, and branch circuit conductors with factory-applied colored insulation for No. 8 AWG and smaller (except: No. 6 AWG and smaller for green ground wire); 1-inch band of colored tape at all splices and terminations for No. 6 AWG and larger (except: No. 4 AWG and larger for green ground wire) as follows:
      a. Table 1:

208Y/120V	Phase	480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

M. Group circuits in conduit such that no conduit contains more than a total of three phase conductors, three neutral conductors, and one ground conductor (unless indicated or specified otherwise).
N. Install wire and cable numbers on all field wiring that matches electrical schematics.

3.04 CONNECTIONS:
A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated.
   1. Lighting and receptacle circuit connectors for No. 10 AWG and smaller shall be twist-on solderless connectors. Provide silicone filled twist-on watertight/raintight connectors for all lighting circuits and receptacles circuits routed outdoors or indoors in wet locations.
   2. Non-lighting and non-receptacle circuit connectors for No. 12 AWG and larger shall be solderless connectors.
   3. All uninsulated joints shall be taped to provide an insulation value equal to that of the wire.
B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
C. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:
A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 33 – Raceways, Boxes, Sleeves, Seals And Fittings For Electrical Systems.

3.06 FIELD QUALITY CONTROL:
A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
   2. Prior to energizing, check all installed feeders and cables with insulation megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Record and submit all field test data. Megger 300V cables with 500Vdc megohm meter between each conductor and ground. Megger 600V cables with 1,000Vdc megger between each

conductor and ground. Also, megger between adjacent conductors. Megger cables after installation (not on cable reel) with cables disconnected at both ends. The values must be approximately as follows:

Conductor Size AWG or MCM)	Resistance (Megohms-1,000 ft.)
14-8	200
6-2/0	100
3/0-500	50

3. Do not test wires or cables with an ac test set.
4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Torque bolted connections to manufacturer's recommendations. Perform tests with calibrated torque wrench and include wrench calibration testing certification information on test form.

C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. UTP cabling and hardware.
   2. 09/125-micrometer, single mode optical fiber cabling and hardware.
   3. RS-232/RS-485 cabling.
   4. Instrumentation cable
   5. Low-voltage control cabling.
   6. Control-circuit conductors.
   7. Identification products.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. American National Standards Institute (ANSI):
      a. ANSI-J-STD-607 A - Commercial Building Grounding/Bonding/Requirement Standard.
   2. Building Industry Consulting Service International (BICSI):
      a. BICSI ITSIM - Information Transport Systems Installation Manual.
      b. BICSI TDMM - Telecommunications Distribution Methods Manual.
   3. Insulated Cable Engineers Association, Inc. (ICEA):
      a. ICEA S-83-596 - Fiber Optic Premises Distribution Cable.
      b. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for use in General Purpose and LAN Communication Wiring Systems.
      c. ICEA S-102-700 - Category 6 Individually Unshielded Twisted Pair Indoor Cables for Use In Communications Wiring Systems.
      d. ICEA S-103-701- Riser Cables Technical Requirements.
   4. National Electrical Contractors Association (NECA):
      a. NECA 1 - Good Workmanship in Electrical Contracting.
   5. National Electrical Manufacturers Association (NEMA):
      a. NEMA WC 66 - Performance Standard for Category 6 and 7 100 Ohm Shielded and Unshielded Twisted Pair Cables.
   6. National Fire Protection Association (NFPA):
      a. NFPA 70 - National Electrical Code.
      b. OESC – Oregon Electrical Specialty Code (Based on NFPA 70)
      c. NFPA 262 - Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   7. Telecommunications Industry Association (TIA):
      a. TIA-492AAAA-B - Detail Specification for 62.5 mm Core Diameter/125 mm Cladding Diameter Class 1A Graded-Index Multimode Optical Fibers.
      b. TIA-492AAAB-A - Detail Specification for 50 mm Core Diameter/125 mm Cladding Diameter Class 1A Graded-Index Multimode Optical Fibers.

c. TIA-526-14-A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - OFSTP-14a.
d. TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises.
e. TIA-568-C.1 - Commercial Building Telecommunications Cabling.
f. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components.
g. TIA-568-C.3 - Optical Fiber Cabling Components.
h. TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.
i. TIA-598-C - Optical Fiber Cable Color Coding.
j. TIA-604-12: FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ.
k. TIA-604-2-B - FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
l. TIA-604-3-B - FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SCAPC.
m. TIA-606-A - Administration Standard for the Commercial Telecommunications Infrastructure.

8. Underwriters Laboratories Inc (UL):
   a. UL 44 - Thermoset-Insulated Wires and Cables.
   b. UL 83 - Thermoplastic-Insulated Wires and Cables.
   c. UL 444 - Communications Cables.
   d. UL 969 - Marking and Labeling Systems.
   e. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords.
   f. UL 1651 - Optical Fiber Cable.
   g. UL 1666 - Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.
   h. UL 1685 - Vertical Tray Fire - Propagation and Smoke - Release Test for Electrical and Optical Fiber Cables.

1.04 DEFINITIONS:

A. EMI: Electromagnetic interference.
B. IDC: Insulation displacement connector.
C. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control and signaling power-limited circuits.
E. NRTL: Nationally Recognized Testing Laboratory.
F. RCDD: Registered Communications Distribution Designer.
G. UTP: Unshielded twisted pair.

1.05 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
C. Source quality-control reports.
D. Field quality-control reports.
E. Maintenance Data: For wire and cable to include in maintenance manuals.

1.06 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Member Company of an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 450 or less.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
   3. Test each pair of UTP cable for open and short circuits.

1.08 PROJECT CONDITIONS:

A. Environmental Limitations: Do not deliver or install UTP and optical fiber cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.01 LISTING:

A. All products, cables and equipment shall be UL listed.

2.02 PATHWAYS:

A. Support of Open Cabling: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.
B. Cable Trays: Comply with requirements in SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS
C. Conduit and Boxes: Comply with requirements in SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

2.03 UTP CABLE:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden.
   2. or approved equal.

B. Description: Category 6, 100-ohm, four-pair UTP. Shall be copper, stranded, underground/burial, with waterblock, sunlight resistant, oil resistant, UL listed.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-B.1 for performance specifications.
   3. Comply with TIA/EIA-568-B.2, Category 6.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
      b. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.

2.04 UTP CABLE HARDWARE:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden.
   2. or Engineer-approved equal.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: Provide blocks for the number of cables terminated on the block, 25% spare; integral with connector bodies, including plugs and jacks where indicated.

2.05 OPTICAL FIBER CABLE:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden.
   2. or approved equal.

B. Description: Fiber type and strand count as identified on drawings.
   1. Shall be loose tube, indoor/outdoor, underground/burial, bend insensitive, water block, oil resistant, rodent resistant, polyethylene jacket, suitable for use in cable tray, UL listed.
   2. Comply with ICEA S-83-596 for mechanical properties.
   3. Comply with TIA/EIA-568-B.3 for performance specifications.
   4. Comply with TIA/EIA-492-CAAA for detailed specifications.
   5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   6. Maximum Attenuation: 1 dB/km at 1310 nm; 0.4 dB/km at 1550 nm.
   7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:
   1. Jacket Color: Yellow for 9/125-micrometer cable.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1,000 mm).

2.06 OPTICAL FIBER CABLE HARDWARE:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden.
   2. Or Engineer-approved Equal

B. Cable Connecting Hardware: Comply with the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
   1. Quick-connect, simplex and duplex, Type LC connectors or as required. Insertion loss not more than 0.75 dB.
   2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.07 RS-232/RS-485 CABLE:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Belden
   2. Engineer-approved equal.

B. Description: Cable used for communication via RS-485 or RS-232 shall be 600V, twisted-shielded pair (TSP) type, tinned copper conductors, PVC/nylon conductor insulation and PVC overall jacket, overall 100 % aluminum foil-polyester tape shield, tinned stranded copper drain wire. Cable shall be sunlight resistant, oil resistant, suitable for use outdoors and below-grade, and UL listed. See Subcontract Drawings for additional requirements.

2.08 INSTRUMENTATION CABLE:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Belden.
   2. Engineer-approved equal.

B. Description: Instrumentation cable for analog instruments shall be Twisted-Shielded Pair (TSP) type, 600V UL type TC-ER multiconductor cable with a single #16 AWG (or as indicated on drawings), PVC/nylon conductor insulation and PVC overall jacket, overall 100% aluminum foil-polyester tape shield, #16 AWG tinned stranded copper drain wire. Cable shall be suitable for use outdoors and below-grade. See Contract Drawings for additional requirements.

2.09 LOW-VOLTAGE CONTROL CABLE:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. General Cable Corporation.
   2. Southwire Company.
   3. Rome Cable Co.
   4. Approved Equal.

B. Copper stranded with 600V rating, UL listed, tray cable (TC-ER), Type XHHW-2, PVC overall jacket, sunlight resistant per UL 1277.

2.10 CONTROL-CIRCUIT CONDUCTORS:

A. Class 1 Control Circuits: 600V, stranded copper, type XHHW-2, in raceway, complying with UL 83.

B. Class 2 Control Circuits: 600V, stranded copper, type XHHW-2, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.11 IDENTIFICATION PRODUCTS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady Corporation.
   2. HellermannTyton.
   3. Kroy LLC.
   4. Panduit Corp.
   5. or Engineer-approved equal.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 26 05 53 – Identification for Electrical Systems.

2.12 SOURCE QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to evaluate cables (NETA, BICSI).

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUCTORS AND CABLES:

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA/EIA-568-B.1.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
   6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   1. Comply with TIA/EIA-568-B.2.
   2. Install 110-style IDC termination hardware unless otherwise indicated.
   3. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:
   1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 – Raceway and Boxes for Electrical.

E. Optical Fiber Cable Installation:
   1. Comply with TIA/EIA-568-B.3.
   2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

F. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
   5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
   6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.02 REMOVAL OF CONDUCTORS AND CABLES:

A. Conductors or cables identified for demolition or made abandoned by new work are to be removed back to source.

3.03 CONTROL-CIRCUIT CONDUCTORS:

A. Minimum Conductor Sizes:
   1. Class 1 remote-control and signal circuits, 14 AWG.
   2. Class 2 low-energy, remote-control, and signal circuits, 16 AWG.
   3. Class 3 low-energy, remote-control, alarm, and signal circuits, 12 AWG.

3.04 FIRESTOPPING:

A. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.05 GROUNDING:

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in SECTION 26 05 26 - Grounding and Bonding for Electrical Systems.

3.06 IDENTIFICATION:

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A. Comply with requirements for identification specified in SECTION 26 05 53 – Identification for Electrical Systems.

3.07 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections (NETA, BICSI).

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not after cross connection.
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
4. Optical Fiber Cable Tests:
    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:
        (1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        (2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
5. Instrument and Control Cables:
    a. Perform continuity check on each conductor before the cable is terminated. Check for faults between cable and ground.
    b. Visually inspect cables for damage.
    c. Verify that cables are installed per drawings and specifications.

d. Verify that conductors are terminated and tagged per drawings and specifications.
e. Test all bolted connections and confirm torque levels are in accordance with manufacturer's published data.
f. Defective cables shall be replaced.

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

END OF SECTION 26 05 23

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies electrical grounding and bonding as indicated on Drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this Section includes the following:

1. Solidly grounded. Grounded through a ground connection in which no impedance has been intentionally inserted.

C. Applications of electrical grounding and bonding work in this Section include the following:

1. Underground metal piping.
2. Underground metal structures.
3. Metal building frames.
4. Electrical power systems.
5. Grounding electrodes.
6. Counterpoise grounding loops.
7. Separately derived systems.
8. Raceways.
9. Boxes and enclosures.
10. Equipment.
11. Lighting stanchions and poles.
12. Signs.
13. Lightning protection systems.

D. Refer to other DIVISION 26 Sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work.

1.03 RELATED REQUIREMENTS:

A. Division 1 for Substitutions, Submittals, and Closeout.
B. Division 31 for excavation for electrical installations within the building boundaries and from building to utility connections.
C. Division 03 for concrete.
D. Section 25 30 01 – Instrumentation for Fuel Systems
E. Section 25 50 01 – Facility Controls for Fuel Systems
F. Section 26 05 10 – Basic Electrical Requirements
G. Section 26 05 19 – Low Voltage Electrical Power Cables
H. Section 26 05 23 – Instrumentation and Control Cables
I. Section 26 05 29 – Hangars and Supports for Electrical Systems
J. Section 26 05 33 – Raceways, Boxes, Sleeves, Seals, and Fittings for Electrical Systems
K. Section 26 05 53 – Identification for Electrical Systems
L. Section 26 41 13 – Lightning Protection for Structures
M. Section 26 56 10 – Exterior Lighting

1.04 REFERENCES:

A. Applicable Standards:

1. Institute of Electrical and Electronic Engineers (IEEE): Comply with applicable requirements and recommended installation practices of the following IEEE Standards pertaining to grounding and bonding of systems, circuits, and equipment:
   a. 32 - Requirements, Terminology, and Test procedures for Neutral Grounding Devices.
   b. 80 - Guide for Safety in Substation Grounding.
   c. 81 - Guide for Measuring Ground Resistance, and Potential Gradient in the Earth.
   d. 141 - Recommended Practice for Electric Power Distribution for Industrial Plants.
   e. 142 - Recommended Practice for Grounding Industrial and Commercial Power Systems.
2. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits, and equipment.
   b. 780 - Lightning Protection Code.
   c. OESC – Oregon Electrical Specialty Code (based on NFPA 70)
3. Underwriters Laboratories (UL): Comply with applicable requirements of the following standards. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
   a. 467 - Electrical Grounding and Bonding Equipment.
   b. 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   c. 869 - Electrical Service Equipment.

1.05 SUBMITTALS:

A. Refer to Subcontract, Subcontract Drawings and Section 26 05 10 Basic Electrical Requirements for administrative and procedural requirements for Submittals.

B. Includes, but not limited to, the following:

1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
2. All field test reports.
   a. NETA Test Results

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide grounding and bonding products of one of the following (for each type of product):

1. Grounding Products:
   a. Adalet-PLM Div; Scott Fetzer Co.
   b. Anderson/Square D.

c. Burndy Corporation.
d. Cadweld Div; Erico Products Inc.
e. Crouse-Hinds Div; Cooper Industries.
f. Ideal Industries, Inc.
g. Joslyn Corporation.
h. Myers Electric Products, Inc.
i. O. Z. Gedney Div; General Signal Corp.
j. Thomas and Betts Corp.

2.02 GROUNDING AND BONDING:

A. Materials and Components:

1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Subcontractor's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.
2. Conductors: Unless otherwise indicated, provide insulated electrical grounding conductors for equipment grounding conductor connections that match power supply wiring materials and as a minimum are sized according to the NEC. Provide uninsulated, stranded, tinned, copper cable for ground electrode conductors.
3. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
   a. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   b. Irreversible Compression Connectors: Irreversible compression connectors of types recommended by kit manufacturer for materials being joined and installation conditions.
   c. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals and long-barrel, two-bolt connection to ground bus bar.
4. Ground Rods or Ground Electrodes:
   a. Grounding Electrodes: Steel with copper clad exterior, 3/4-inch diameter by 10 feet (minimum) long.
5. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required or indicated.
6. Field Welding: Provide exothermic welded connections where grounding conductors connect to underground grounding conductors and underground grounding electrodes.

PART 3 - EXECUTION

3.01 APPLICATIONS:

A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation,"

and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

C. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum, unless otherwise noted.
   1. Bury at least 24 inches (600 mm) below grade.
   2. Duct-Bank Grounding Conductor: Construct with duct bank when indicated as part of duct-bank installation.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Exothermic welds except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Bolted connectors.
   5. Clean metal contact surfaces of clamp-on connectors to ensure electrical conductivity and circuit integrity.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS:

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 2/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

3.03 EQUIPMENT GROUNDING:

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug on substation, switchgear, switchboard, motor control center, or panelboard ground bus. When conduit enters from below and is not connected to the enclosure, ground equipment grounding conductor on conduit grounding bushing and then bond to ground bus (or grounded enclosure if there is no ground bus).

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.

6. Flexible raceway and power cords runs.
7. Computer and Rack-Mounted Electronic Equipment circuits: Install insulated equipment grounding conductor from grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
8. Ground wireways at least once and at 10-foot intervals.

D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No.-4-AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.04 INSTALLATION:

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 10 inches below finished floor or final grade unless otherwise indicated. Do not drill or jet. Drive ground rods into unexcavated portions of earth where possible. If rods must be driven into excavated areas, drive rods after compaction of backfill is completed.
1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Installed per drawings. Shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use irreversible compression connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Ground Counterpoise Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of area or item indicated.

1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building and equipment.

G. Ufer Ground (Concrete-Encased Grounding Electrode): Installed in ductbanks. Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4/0AWG.

H. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

I. Weld grounding conductors to underground grounding conductors and underground electrodes. Ground electrode conductor shall not contain splices between the ground electrode and the service entrance equipment.

J. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

K. Ground each separately derived system neutral to:
1. Effectively grounded structural steel member or ground counterpoise.
2. Main building ground system.

L. Bond the system neutral to service entrance equipment enclosures.

M. Ground all exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground conductors, and metallic plumbing systems.

N. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

O. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

3.05 LABELING:

A. Comply with requirements in Section 26 05 53 Identification for Electrical Systems for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer.
1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.06 FIELD QUALITY CONTROL:

A. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify and document compliance with test parameters by NETA certified.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.
F. Report measured ground resistances that exceed the following values:
    1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
    2. Power and Lighting Equipment or System with Capacity of 500 to 1,000 kVA: 5ohms.
    3. Power and Lighting Equipment or System with Capacity More Than 1,000 kVA: 3ohms.
    4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohms.
G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies hangers, supports, anchors, sleeves, and seals for electrical equipment and systems as well as construction requirements for concrete bases as indicated by Drawings and schedules and/or specified in other Division 26 Sections.
B. Types of hangers, supports, anchors, sleeves, and seals specified in this Section include the following:
   1. Clevis hangers.
   2. Riser clamps.
   3. Steel rod coupling.
   4. C-clamps.
   5. I-beam clamps.
   6. One-hole conduit straps.
   7. Two-hole conduit straps.
   8. Hexagonal nuts.
   9. Round threaded steel rods.
   10. Conduit clamps.
   11. U-bolts.
   12. Lead expansion anchors.
   13. Toggle bolts.
   14. Wall, ceiling, roof and floor seals.
   15. Conduit cable supports.
   16. U-channel strut system.
   17. Fire and smoke stop compounds.

1.03 RELATED REQUIREMENTS:

A. Concrete materials, reinforcement, and placement requirements are specified in Division 03 – Concrete.
B. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly in other Division 26 Sections.
C. Section 26 05 10 – Basic Electrical Requirements.
D. Section 26 05 26 – Grounding And Bonding For Electrical Systems.
E. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM):
   1. ASTM-A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

2. ASTM-E814 REV A - Standard Test Method for Fire Tests of Penetration Firestop Systems, pertaining to fire stop components.

C. American Welding Society (AWS):
1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. National Fire Protection Association (NFPA):
1. NFPA-70 - National Electrical Code (NEC).
2. OESC – Oregon Electrical Specialty Code (based on NFPA 70)

E. National Electrical Contractors Association (NECA):
1. NECA 1 – Standard Practice of Good Workmanship In Electrical Construction.

F. Society of Protective Coatings (SSPC):
1. SSPC-PA 1 - Shop, Field and Maintenance Painting of Steel.

G. Underwriters Laboratories (UL):
1. Provide electrical devices, components, and fire stops which are UL-listed and labeled.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.06 SUBMITTALS:

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Includes, but not limited to, the following:
1. Product Data: Submit manufacture's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.

C. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating weights, strength, details of fabrication, and details of materials.

1.07 QUALITY ASSURANCE:

A. Comply with NFPA 70.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.08 COORDINATION:

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
   1. Hilti, Inc.
   2. Ideal Industries, Inc.
   3. Joslyn Manufacturing Co., Inc.
   4. Eaton/Cooper; McGraw Edison Co.
   5. Unistrut; Atkore International.

B. Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. Allied Tube & Conduit Corp.
   2. Eaton/Cooper; B-Line Systems, Industries.
   3. Erico International Corp.
   4. Kindorf; Thomas & Betts Corp.
   5. Power-Strut; Power Engineering Co.
   6. Unistrut; Atkore International.

C. Fire and Smoke Stop Compounds: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. 3M Company.
   2. Hilti, Inc.

2.02 MATERIALS:

A. General: Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as herein specified. All supports shall be designed for the support of the maximum number of conduits and their maximum conductor weights for maximum conduit loading. Where more than one type of supporting device meets indicated requirements, selection is Subcontractor's option. Do not use perforated metal straps for supports.

B. Supports: Supporting devices of types, sizes, and materials indicated, and having the following construction features.
   1. Clevis Conduit Hangers: For supporting conduit; galvanized steel; with 3/8-, 1/2-, 5/8- or 3/4-inch rod, size of clevis and rod as required.
   2. Riser Clamps: For supporting conduit, galvanized steel, with two bolts and nuts.
   3. Steel Rod Couplings: Provide 3/8-, 1/2-, 5/8- or 3/4-inch straight rod couplings, size as required.
   4. C-Beam Clamps: Malleable iron, 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.
   5. I-Beam Clamps: Galvanized steel, with 3/8, 1/2-, 5/8-, or 3/4-inch rod, size as required; 3/8-inch horizontal "J" hook safety rod that bolts across the flange, flange width as required.
   6. One-Hole Conduit Straps: For supporting conduit; stamped plated steel, size as required.
   7. Two-Hole Conduit Straps: For supporting conduit, stamped plated steel, size as required.
   8. Hexagonal Nuts, Flat Washers and Lock Washers: For 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required; galvanized steel.
   9. Round Threaded Steel Rod: Galvanized steel, 3/8-, 1/2-, 5/8-, or 3/4-inch diameter, size as required. Minimum size is 3/8-inch diameter.

10. Conduit Clamps: For supporting conduit; galvanized stamped steel, size as required.
11. U-Bolts: For supporting conduit; galvanized, size as required.

C. Anchors: Anchors of types, sizes and materials indicated, with the following construction features.
1. Lead Expansion Anchors: 1/2, 5/8, or 3/4 inch as required.
2. Toggle Bolts: Springhead, 3/16 by 4 inch or larger size as required.

D. Sleeves and Seals: Sleeves and seals of types, sizes, and materials indicated, with the following construction features:
1. Pipe Sleeves: When penetrating a wall, ceiling roof or floor, provide pipe sleeves of one of the following:
a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal: 3 inches and smaller, 20 gauge; 4 inch to 6 inch, 16 gauge; over 6 inches, 14 gauge.
b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
c. Iron Pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
d. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
2. Wall, Roof and Floor Seals: Provide sleeves for conduit which penetrate foundation walls below grade, floors, ceilings, or exterior walls. Caulk between sleeve and conduit with nontoxic, UL-classified caulking material to ensure watertight seal.
3. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Seal fire rating shall equal or exceed that of the wall or floor penetrated.
4. Provide a fire-rated sleeve and seal equal to or exceeding the fire rating of the ceiling, floor or wall being penetrated.

E. Conduit Cable Supports: Cable supports with insulating wedging plug for nonarmored type electrical cables in risers; construct for rigid metal conduit (size as required) number of wires as required, type wire as specified; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems: Unless indicated otherwise, U-channel strut system for supporting electrical equipment, 12-gauge steel hot-dip galvanized after fabrication for wet and outdoor locations, 12-gauge standard green paint finish for dry and indoor locations, of types and sizes indicated; construct with 9/16-inch diameter holes, 8 inch on-center on top surface, and with the fittings as required which mate and match with U-channel.

G. Fire and Smoke Stop Compounds: Provide one of the following:
1. 3M Fire Barrier 2000+.
2. Hilti, Inc. FS-ONE MAX.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. Install hangers, anchors, sleeves, and seals as specified, required, and indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA and NFPA 70 for installation of supporting devices.

B. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacing indicated and as required by NFPA 70 or as indicated when less than NFPA 70 required spacing.
C. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.
D. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
E. Repair damage to painted finishes with paint recommended by manufacturer.
F. Install fire and smoke stop compounds at all penetrations of fire rated walls, floors, ceilings, and roofs. Install fire and smoke stop compounds in accordance with manufacturer's instructions to provide a fire seal rating equal to or greater than that of the surface penetrated.
   1. Testing shall be performed in accordance with ASTM-E814 REV A and applicable local codes.
G. Provide seismic support and bracing for all multiple conduit supports plus individually supported conduit 2-1/2 inches and larger such that the supports shall resist the forces of wind and seismic loading per the structural drawings.
H. Provide seismic support and bracing for all busway and cable tray such that the support shall resist the forces of wind and seismic loading per the structural drawings.

3.02 CONCRETE BASES:

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 - Concrete.
C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.03 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies the following:
   1. Conduit.
   2. Wireway.
   3. Surface metal raceways.
   4. Outlet and device boxes.
   5. Weatherproof boxes.
   6. Junction boxes.
   7. Pull boxes.
   8. Floor boxes.
   9. Fittings.
   10. Bushings and ground bushings.
   11. Locknuts.
   12. Knockout closures.
   13. Telephone terminal cabinets.
   14. Supports and accessories.
   15. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   16. Sleeve-seal systems.
   17. Sleeve-seal fittings.
   18. Grout.
   19. Silicone sealants.

1.03 RELATED REQUIREMENTS:

A. Division 31 – Trenching and Backfilling.
B. Section 26 05 10 - Basic Electrical Requirements
C. Section 26 05 23 – Control-Voltage Electrical Power Conductors and Cables
D. Section 26 05 29 - Hangers and Supports for Electrical Systems
E. Section 26 05 53 - Identification for Electrical Systems

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. National Electrical Contractors Association (NECA):
   1. NECA NEIS 1 - Standard Practice of Good Workmanship in Electrical Construction.
C. National Electrical Manufacturers Association (NEMA):
   1. NEMA C80.1 - Electrical Rigid Steel Conduit (ERSC).
   2. NEMA C80.3 - Steel Electrical Metallic Tubing (EMT).

3. NEMA RN1 - PolyVinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
4. NEMA TC-2 - Electrical Polyvinyl Chloride (PVC) Conduit.
5. NEMA TC-3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
6. NEMA TC-6 and 8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installation.
7. NEMA TC-9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
8. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
9. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
10. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).

D. National Fire Protection Association (NFPA):
1. NFPA-70 - National Electrical Code, (NEC). Comply with applicable requirements of NEC pertaining to construction and installation of raceway systems.
2. OESC – Oregon Electrical Specialty Code

E. Underwriters Laboratories (UL):
1. Provide all devices and equipment which are UL listed and labeled.
2. UL 1 - Standards for Flexible Metal Conduit.
3. UL 5, 5A, 5B, 5C - Standard for Surface Metal Raceways and Fittings.
4. UL 6 - Electrical Rigid Metal Conduit – Steel.
5. UL 50, 50E - Standard for Enclosures for Electrical Equipment.
6. UL 360 - Standard for Liquid-Tight Flexible Metal Conduit.
7. UL 467 - Grounding and Bonding Equipment.
8. UL 514A - Metallic Outlet Boxes.
9. UL 514B - Conduit, Tubing, and Cable Fittings.
10. UL 514C - Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
11. UL 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
12. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
13. UL 797 - Electrical Metallic Tubing – Steel.
14. UL 870 - Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
15. UL 1203 - Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
16. UL 1242 - Standard for Electrical Intermediate Metal Conduit – Steel.

1.05 SUBMITTALS:

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Submittals shall include, but not be limited to, the following:
1. Product Data:
a. Submit manufacturer's technical product data, including specifications and installation instructions, for each type of product required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer:
1. Subject to compliance with requirements, provide each type of raceway from one of the following:
a. Rigid Steel Conduit:
(1) Allied Tube & Conduit; Atkore International.
(2) Republic Conduit, Inc.
(3) Wheatland Tube Co.
b. EMT:
(1) Allied Tube and Conduit; Atkore International.
(2) Republic Conduit, Inc.
(3) Wheatland Tube Co.; JMC Steel Group.
c. PVC Coated Rigid Steel Conduit:
(1) Externally Coated:
(a) Allied Tube and Conduit; Atkore International.
(b) Calbond; Calpipe Industries, Inc.
(c) Perma-Cote Coated Conduit; Robroy Industries.
(2) Externally and Internally Coated:
(a) Perma-Cote Coated Conduit; Robroy Industries.
(b) Calbond; Calpipe Industries, Inc.
d. Liquid-Tight, Flexible Metal Conduit:
(1) AFC Cable Systems; Atkore International.
(2) Anaconda Sealtite; Division of ANAMET Electrical, Inc.
(3) Electri-Flex Co.
(4) Southwire Company.
e. Rigid Metal Conduit Fittings:
(1) Appleton; EGS Electrical Group.
(2) Raco; Hubbell Company.
(3) Thomas & Betts Corp.
f. Flexible Metal Conduit Fittings:
(1) Appleton; EGS Electrical Group.
(2) Electri-Flex Co.
(3) O-Z/Gedney; EGS Electrical Group.
g. Liquid-tight Flexible Metal Conduit Fittings:
(1) Appleton; EGS Electrical Group.
(2) Electri-Flex Co.
(3) O-Z/Gedney; EGS Electrical Group.
h. EMT Fittings:
(1) Appleton; EGS Electrical Group.
(2) Raco; Hubbell Company.
(3) Thomas & Betts Corp.
i. Nonmetallic Rigid Conduit and Fittings:
(1) Carlon; Thomas & Betts Corp.

(2) Prime Conduit.

j. Wireway:
   (1) Hoffman; Pentair Equipment Protection.
   (2) Schneider Electric.

k. Surface Metal Raceway:
   (1) Hubbell Wiring Systems.
   (2) MonoSystems.
   (3) Panduit.
   (4) Wiremold; Legrand.

l. Conduit Bodies:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow-Hart Div; Cooper Industries.
   (3) Killark; Hubbell Inc.
   (4) O-Z/Gedney; EGS Electrical Group.

m. Interior Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Bell; Hubbell, Inc.
   (3) O-Z/Gedney; EGS Electrical Group.
   (4) Pass and Seymour; Legrand.
   (5) Raco; Hubbell, Inc.
   (6) Steel City; Thomas & Betts Corp.

n. Weatherproof Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow Hart; Eaton.
   (3) Hubbell, Inc.
   (4) O-Z/Gedney; EGS Electrical Group.
   (5) Pass and Seymour; Legrand.

o. Junction and Pull Boxes:
   (1) Appleton; EGS Electrical Group.
   (2) Arrow Hart; Eaton.
   (3) Bell Electric, Square D Company.
   (4) Hoffman Engineering Company.
   (5) O-Z/Gedney; EGS Electrical Group.

p. Bushings, Grounding Bushings and Locknuts:
   (1) Arrow Hart; Eaton.
   (2) Appleton; EGS Electrical Group.
   (3) O-Z/Gedney; EGS Electrical Group.
   (4) Raco; Hubbell, Inc.
   (5) Steel City; Thomas & Betts Corp.

q. Electrical Enclosures:
   (1) Hoffman; Pentair Equipment Protection.
   (2) Wiegmann; Hubbell, Inc.

r. Sleeve-Seal Systems:
   (1) Advance Products & Systems, Inc.
   (2) CALPICO, Inc.
   (3) Metraflex Company (The).

(4) Pipeline Seal and Insulator, Inc.
(5) Proco Products, Inc.

s. Sleeve-Seal Fittings:
(1) Link-Seal.
(2) Presealed Systems.

2.02 METAL CONDUIT AND TUBING:

A. General: Provide metal conduit, tubing, and fittings of types, grades, sizes, and weights (wall thicknesses) for each service indicated. Where types and grades are not specified or indicated, provide proper selection to fulfill specified requirements, and comply with applicable portions of NEC for raceways. Minimum size shall be 3/4 inch, unless indicated or specified otherwise.

B. Rigid Steel Conduit: Rigid steel, zinc coated, threaded type conforming to UL 6A.
1. Zinc coating fused to inside and outside walls.

C. Electrical Metallic Tubing (EMT): UL 797.

D. PVC Externally and Internally Coated Rigid Steel Conduit: Rigid steel zinc coated with additional external 40 mil coating of PVC and 2 mil urethane internal coating conforming to NEMA RN1. Coating shall be bonded to conduit. Extruded coating shall not be accepted.

E. Flexible Metal Conduit (indoor use only): UL 1. Formed from continuous length of spirally-wound, interlocked zinc-coated strip steel. Minimum size shall be 1/2 inch unless indicated or specified otherwise. Approved as a grounding path for circuits rated 20 amperes or less and in lengths of 6 feet and less.

F. Liquid-Tight, Flexible Metal Conduit: Liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with oil-resistant, liquid-tight thermoplastic jacket. Approved as a grounding path in conduit sizes 1-1/4 inch and smaller and in lengths 6 feet or less when protected as follows:
1. 3/8 inch and 1/2 inch protected at 20 amperes or less.
2. 3/4-inch, 1 inch and 1-1/4 inch protected at 60 amperes or less.
3. An equipment grounding conductor shall span the entire length of the liquid-tight, flexible metal conduit per Article 501 of the NEC.

G. Rigid Metal Conduit Fittings: Threaded cast-malleable iron, galvanized or cadmium plated, conforming to UL 514B.
1. Provide steel fittings for steel conduit.

H. Flexible Metal Conduit Fittings: Threadless hinged clamp type. Provide conduit fittings for use with flexible steel conduit. Fittings shall be approved for grounding per NFPA 70 Article 348.60.
1. Straight Terminal Connectors: One-piece body, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provide with locknut.
2. 45 degree or 90-degree Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

I. Liquid-Tight Flexible Metal Conduit Fittings: Provide cadmium plated, malleable-iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated or non-insulated throat. Fittings shall be approved for grounding in conduit sizes 1-1/4 inch and smaller per NFPA 70 Article 350.60.

J. EMT Fittings: Steel compression type.

K. Conduit Bodies: Galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NFPA-70 requirements. Construct conduit bodies with threaded conduit entrance ends, removable covers, either cast or of galvanized steel, and corrosion-resistant screws.

L. Conduit and Tubing Accessories: Provide conduit and tubing accessories of types, sizes, and materials, complying with manufacturer's published product information which mate and match conduit and tubing.

M. Conduit Bushings: Provide insulated throat for all bushings. Grounding bushings shall have an integral copper set-screw type cable grounding lug.

N. Explosionproof flexible metal conduit rated for Class I, Div. 1 Group D.

O. Explosionproof conduit seal fittings sizes 1/2 inch through 3-1/2 inch shall have expanded fill sealing area such that they are UL listed for use with 40% filled conduit. Conduit seal sealant shall be manufactured by the fitting manufacturer.

2.03 NONMETALLIC CONDUIT AND FITTINGS:

A. General: Provide nonmetallic conduit, ducts, and fittings of types, sizes, and weights for each service indicated. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements which comply with provisions of NFPA 70 for raceways. Minimum size shall be 3/4 inch, unless indicated otherwise.

B. Electrical Plastic Conduit:

1. Heavy-Wall Conduit: Schedule 40, 90ºC, UL rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial or normal aboveground use, UL listed, and in conformity with NFPA 70 Article 352.

C. PVC Conduit Fittings: NEMA TC-3, mate and match to conduit or tubing type and material.

D. Underground PVC Plastic Utilities Duct: NEMA TC-6 and -8, EB-35 for encased burial in concrete.

E. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC-9, mate and match to duct type and material.

F. Conduit and Tubing Accessories: Provide conduit, tubing, and duct accessories of types, sizes, and materials, complying with manufacturer's published information which mate and match conduit and tubing.

2.04 WIREWAYS:

A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated or required. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as required for complete system.

B. Lay-in Wireways: NEMA enclosure as indicated. If not clearly indicated, enclosure shall be NEMA 4X type. Provide 2.5 by 2.5 inch, 4 by 4 inch, 6 by 6 inch, 8 by 8 inch, and 12 by 12-inch sizes as indicated or required. Construct lay-in wireways with hinged covers, in accordance with UL 870 and with components UL listed, including lengths, connectors, and fittings. Wireways shall allow fastening hinged cover closed without use of parts other than standard lengths, fittings, and connectors. The 2 1/2-inch, 4-inch and 6-inch wireways shall be constructed with 16 gauge steel. The 8-inch and 12-inch wireways shall be constructed with 14-gauge steel. Wireway shall be painted with epoxy paint. Units shall be capable of sealing

cover in closed position with screws. Provide NEMA 1 wireways in the 2 1/2-inch, 4 inch and 6 inch sizes with knockouts.

1. Connectors: Provide wireway connectors suitable for lay in conductors, with connector covers permanently attached such that removal is not necessary to utilize the lay in feature.
2. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

C. Raintight Lay in Wireway: NEMA 3R Enclosure. Provide 4 by 4 inch, 6 by 6 inch, 8 by 8 inch, and 12 by 12-inch sizes as required or indicated. Construct raintight lay in wireways with hinged covers in accordance with UL 870 and with components UL listed, including lengths, connectors, and fittings. Design units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings, and connectors. Construct units to be capable of sealing cover in closed position with screws.

1. Construction: 16-gauge galvanized sheet metal parts for 4-inch by 4-inch to 6-inch by 6-inch sections, and 14-gauge parts for 8 inch by 8 inch and larger sections. Do not use gasketing that can rip or tear during installation or would compromise raintight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.
2. Finish: Provide 14-gauge and 16-gauge galvanized sheet metal parts with corrosion-resistant primer and baked epoxy enamel finish. Plate hardware to prevent corrosion.

2.05 SURFACE METAL RACEWAYS:

A. Surface Metal Raceways shall comply with UL 5 and UL 5C and be UL labeled.

1. Type 4 Raceway: Two-piece type, divided for power and communication use, lengths as indicated. Provide nominal 4-3/4 inch by 1-3/4 inch with two 2-3/8-inch compartments.
2. Boxes for Surface Raceways: Designed, manufactured, and supplied by raceway manufacturer for use with specified raceway.

2.06 FABRICATED MATERIALS:

A. Outlet Boxes: Galvanized, coated, flat rolled, sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with conduit knockout openings in bottom and sides. Provide boxes with threaded screw holes for grounding screws, fastening devices, box covers, and for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 1.5 inches, provide larger box if required, specified or indicated otherwise.

B. Device Boxes: Galvanized, coated, flat rolled, sheet-steel device boxes, of shapes, cubic inch capacities, and sizes, including box depths as required, indicated, and specified, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, with conduit knockout openings in bottom and sides, and with threaded screw holes for fastening devices and box covers. Provide corrosion-resistant screws for equipment grounding. Minimum box size shall be 4-inch by 4-inch by 1.5 inches, provide larger box if required, specified or indicated otherwise.

1. Device Box Accessories: Provide as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners (use only in existing walls) which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Subcontractor's code-compliance option.

C. Weatherproof Boxes: Corrosion-resistant, cast-metal, weatherproof, outlet wiring boxes, of types, shapes, and sizes, including depth of boxes as required with threaded conduit hubs for fastening electrical conduit. Provide cast-metal face plates with spring-hinged, watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant fasteners.

D. Junction and Pull Boxes: Galvanized, code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes, and sizes, to suit each respective location and installation; with welded seams and equipped with manufacturer's standard corrosion resistant steel nuts, bolts, screws and washers.

E. Bushings: Provide threaded, nylon insulated metallic bushings. Provide steel bushings for conduit sizes 1.5 inches and smaller. Provide malleable iron bushings for conduit sizes 2 inches and larger.

F. Grounding Bushings: Provided where indicated, specified, and required by NEC. Provide threaded, insulated, malleable iron bushing with lay-in screw clamp lug.

G. Locknuts: Provide steel locknuts for conduit sizes 2 inches and smaller. Provide malleable iron for conduit sizes 2.5 inches and larger.

H. Sealing Hub: Provide watertight, threaded, insulated sealing hub connectors for all outdoor and indoor wet locations where conduit enters into enclosures. Sealing hub threaded lengths shall be adequate to allow installation of bushing.

I. Knockout Closures: Provide steel press-in knockout seals for all unused punched out knockouts 2 inches and smaller. Provide steel two-piece bolt on knockout seals for all unused punched out knockouts 2.5 inches and larger.

J. Fittings: Provide all threaded nipples, insulated short elbows, offset nipples, offset connectors, enlargers and reducers as required. Provide EMT compression type connectors with insulated throat. Provide EMT compression type insulated short elbows as required. Provide EMT set-screw type offset connectors as required.

K. Hinged-Cover Enclosures:
1. Comply with UL 50 and NEMA 250, TYPE 4X with continuous-hinge cover with flush latch unless otherwise indicated.
   a. Metal Enclosures: Stainless Steel, finished inside and out with manufacturer's standard enamel.
   b. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:
1. NEMA 250, Type 4X galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Keyed handle.
4. Accessory feet where required for freestanding equipment.
5. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.07 SLEEVES:

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.08 SLEEVE-SEAL SYSTEMS:

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.09 SLEEVE-SEAL FITTINGS:

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.10 GROUT:

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.11 SILICONE SEALANTS:

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
   1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
   2. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 INSTALLATION OF RACEWAYS:

A. General:
   1. Install raceways as indicated in accordance with manufacturer's written installation instructions and in compliance with NEC and OESC. Install raceways plumb and level, and maintain NEC and OESC recommended clearances. Provide raceway supports in accordance with the NEC and Section 26 05 29 - Hangers and Supports For Electrical Systems.

B. Coordinate with other work including wires/cables, boxes, and panel work as necessary to interface installation of electrical raceways and components with other work.

3.02 INSTALLATION OF CONDUITS:

A. General: Install concealed conduits in new construction work - in walls, in slabs, or above suspended ceilings. Run conduits concealed in existing work where practicable. Where conduits cannot be concealed in finished areas, use surface metal raceways only where indicated. Provide holes for conduit in all boxes, panels and enclosures as required.
   1. All conduit installed above grade (including exposed and concealed above removable suspended ceilings) that contains emergency power and emergency lighting conductors shall be identified in accordance with Section 26 05 53 – Identification For Electrical Systems.
   2. Mechanically fasten together metal conduits, enclosures, and raceways to form continuous electrical conductor. Connect to electrical boxes, fittings, and cabinets to provide electrical continuity and firm mechanical assembly.
   3. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.
   4. Install miscellaneous fittings such as reducers, close nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install telescoping type linear expansion fittings in raceways every 200-foot linear run and wherever structural expansion joints are crossed.

5. Use roughing-in dimensions of electrically powered units furnished by unit manufacturer. Set conduit and boxes for connection to units only after receiving dimensions and after checking location with other trades.
6. Test conduits (witnessed by the Contractor) required to be installed but left empty with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition. Provide 200-pound tensile strength nylon conduit fish line throughout the entire length of all empty conduits. Leave 12 inches of slack at each end.
7. Do not install conduit in front of covers of new and existing electrical equipment, pull boxes, and junction boxes.
8. Provide all openings in floors, walls, ceilings and roofs for passage of conduit. Fire ratings of walls, floors, ceiling and roofs shall be maintained when passing through them by providing fire seals in accordance with Section 26 05 29 - Hangers And Supports For Electrical Systems.
9. Where different conduits contain circuits of different noise levels the horizontal and vertical spacing in inches between the outside surfaces of the conduits (or conduit to cable tray) shall not be less than indicated below (unless specified otherwise, indicated otherwise, or required otherwise by the equipment manufacturer):
    a. Noise Level 1 Circuits: Analog circuits less than 50V, digital circuits less than 12V or telephone circuits.
    b. Noise Level 2 Circuits: Analog circuits greater than 50V or digital circuits greater than 12V.
    c. Noise Level 3 Circuits: 120Vac or dc circuits operating at less than 20 amperes.
    d. Noise Level 4 Circuits: Ac or dc circuits less than 800V operating with currents less than 800 amperes.
    e. Noise Level 5 Circuits: Circuits over 800Vac or dc and/or over 800 amperes.

MINIMUM HORIZONTAL AND VERTICAL SPACING BETWEEN

DIFFERENT CONDUIT OUTSIDE SURFACES

(OR CONDUIT TO CABLE TRAY) IN INCHES

NOISE LEVEL	1	2	3	4	5
1	*	1	3	12	12
2	1	*	3	9	12
3	3	3	*	*	6
4	12	9	*	*	*
5	12	12	6	*	*

* = MINIMUM SEPARATION REQUIRED FOR INSTALLATION OF LOCKNUTS AS IF ADJACENT CONDUIT WERE TERMINATING IN AN ENCLOSURE.

10. Provide a weatherproof duct seal compound between the conductors and the inner walls of all conduit that are routed to NEMA 3, 3R, 3S, 4 and 4X enclosures to prohibit moisture and/or humid air from entering the raceway and condensing.

11. Repair damage to galvanized finishes with a zinc-rich paint recommended by the manufacturer.
12. Repair damage to PVC finishes with matching touch-up coating recommended by the manufacturer.
13. Where metallic conduit leaves cast-in-place concrete (to air, to earth or to compacted fill) provide PVC-coated Rigid Galvanized Steel.

B. Conduit Installation: Provide rigid steel zinc-coated conduit where embedded in cast-in-place concrete, in hazardous locations, routed below floor slabs, when containing circuits over 600Vac, routed through cast-in-place masonry, or installed outdoors. Follow minimum requirements in other areas as follows:
1. Use rigid steel zinc-coated conduit in mechanical equipment rooms, electrical equipment rooms, penthouses where exposed to physical damage, crawl spaces, tunnels, service splines, kitchens and cafeterias, and in warehouse spaces below 18 feet-0 inches height, and for 208 and 480V feeder circuits to switchboards, panelboards, switchgear and motor control centers.
2. Use steel zinc-coated EMT for interior 208 and 480V branch circuits, interior concealed 120V power, lighting, alarms, controls, and communications in offices, corridors, toilets, lunchroom areas, lab areas, ceiling plenum areas, and in warehouse spaces above 18 feet-0 inches height.
3. Use flexible steel conduit only in movable partitions and from outlet boxes to interior recessed lighting fixtures (Maximum of 6 feet long and a minimum of 4 feet long in nonenvironmental air plenums. Maximum length in environmental air plenums shall be 4 feet long), and final 24 inches of connection to motors, transformers, and control items. Provide where subject to movement and vibration where connections are in dry, nonhazardous, interior locations. Provide in cells of precast concrete panels.
4. Use liquid-tight flexible conduit in nonhazardous locations (length shall not exceed 6 feet, unless indicated otherwise) where subjected to movement and vibration where connections are subjected to one or more of the following conditions:
    a. Exterior location.
    b. Moist or humid atmosphere where condensation can be expected to accumulate.
    c. Corrosive atmosphere.
    d. Subjected to water spray or dripping oil, water, or grease.
    e. Connected to a motor driving a nonsubmerged pump.
5. Cut conduits straight, properly ream, and cut threads for threaded conduit deep and clean.
6. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.
7. Size conduits as indicated, unless no size is indicated then size per NEC, except no conduit smaller than 3/4 inch shall be embedded in concrete or masonry.
8. Fasten indoor, dry location threaded conduit terminations in sheet metal enclosures by 2 locknuts and terminate with bushing. Install locknuts inside and outside enclosure.
9. Conduits shall not cross pipe shafts, access openings or ductwork openings.
10. Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.
11. Support riser conduit at each floor level with clamp hangers.

12. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.
13. Complete installation of electrical raceways before starting installation of cables/wires within raceways.
14. Use externally PVC coated and internally urethane coated rigid steel conduit where specified or indicated.
15. Provide explosionproof flexible metal conduit where indicated or required.
16. Provide explosionproof conduit seals where indicated or required. Fill conduit seals with sealant as recommended by the manufacturer.
17. Conduit installed above suspended ceilings shall comply with the following:
    a. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
    b. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
    c. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.

C. Concealed Conduits:
1. Metallic raceways in floors below grade or outside are to have conduit threads painted with corrosion inhibiting compound before couplings are assembled. Draw up coupling and conduit sufficiently tight to ensure watertightness.
2. For floors-on-grade, install PVC externally coated rigid steel conduit under concrete slabs. Provide only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
3. Install underground conduits a minimum of 24 inches below finished grade.

D. Conduits in Concrete Slabs:
1. Place conduits between bottom reinforcing steel and top reinforcing steel.
2. Place conduits either parallel or at 90 degrees to main reinforcing steel.
3. Separate conduits by not less than the outside diameter of the largest conduit to ensure proper concrete bond.
4. Conduits crossing in slab must be reviewed for proper cover by the Contractor.
5. Embedded conduit outside diameter shall not exceed 1/3 of slab thickness.

E. Install conduits so as not to damage or run through solid structural members. Avoid horizontal or cross runs in building partitions or side walls.

F. Exposed Conduits:
1. Install exposed conduits and extensions from concealed conduit systems neatly and parallel with or at right angles to walls of building or structure.
2. Install exposed conduit work so as not to interfere with ceiling inserts, windows, doors, lights, ventilation ducts or outlets.
3. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed NEC requirements.
4. Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
5. Above requirements for exposed conduits also apply to conduits installed in space above suspended ceilings and in crawl spaces.

G. Nonmetallic Conduits:
1. Provide only where indicated. Do not install in hazardous locations.

2. Make solvent cemented joints in accordance with recommendations of manufacturer.
3. Install PVC conduits in accordance with NEC and in compliance with local utility practices.
4. All duct banks shall be a minimum of 24 inches below grade. Conduit in duct banks shall have a minimum of 3 inches of concrete cover in all directions. There shall be a minimum of 3 inches of concrete separation between all conduit.
5. All conduit risers from buried conduit or duct banks shall be made with internally urethane coated and externally PVC coated galvanized rigid steel conduit elbows. PVC elbows are not allowed.
6. Horizontal bends do not need to be PVC coated or rigid steel.

H. Conduit Fittings:
1. Provide locknuts for securing conduit to metal enclosures with a sharp edge for digging into metal and ridged outside circumference for proper fastening. Standard locknuts are not acceptable.
2. Provide threaded, nylon insulated bushings for terminating conduits which have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.
3. Provide threaded, grounding bushings of insulated type with copper set screw clamp type lay-in grounding terminal where required by NEC, where indicated or specified.
4. Provide miscellaneous fittings such as reducers, close nipples, 3-piece unions, split couplings, and plugs as required which are specifically designed for their particular application.
5. Provide grounding in accordance with Section 26 05 26 – Grounding and Bonding For Electrical Systems.
6. Provide raintight hubs on all outdoor conduit that are terminated in a nonthreaded enclosure hole.
7. Provide identification of all raceways as specified in Section 26 05 53 – Identification for Electrical Systems.
8. EMT shall have galvanized compression type box connectors at all boxes.
9. Provide raceway sealing fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to adjacent wall plate or surfaces. Provide sealing fittings where:
    a. Conduit enters or leaves hazardous locations.
    b. Where conduit passes from warm locations to cold locations, such as boundaries of refrigerated spaces and air-conditioned spaces.

3.03 INSTALLATION OF SURFACE METAL RACEWAYS AND WIREWAYS:

A. General: Mechanically assemble metal enclosures and surface metal raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings, and cabinets to provide effective electrical continuity and rigid mechanical assembly.
1. Provide only where indicated. Avoid use of dissimilar metals throughout system to eliminate possibility of galvanic corrosion. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
2. Install expansion fittings in all raceways, surface metal raceways, and wireways wherever structural expansion joints are crossed.

3. Make changes in direction of surface metal raceway and wireway with proper fittings supplied by raceway manufacturer. No field bends of surface metal raceway or wireway sections will be permitted.
4. Properly support and anchor surface metal raceways for their entire length with structural materials. Surface metal raceways are not to span any space unsupported.
5. Use boxes as supplied by surface metal raceway manufacturer wherever junction, pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface metal raceway installations.
6. Provide identification of all raceways as specified in Section 26 05 53 – Identification For Electrical Systems.
7. Ground wireways at 10-foot intervals per Section 26 05 26 – Grounding And Bonding For Electrical Systems.

3.04 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. General: Install electrical boxes, bushings, locknuts, nipples, connectors, sealing hubs, and fittings as required, indicated, in accordance with applicable requirements of NEC and OESC and in accordance with recognized industry practices to fulfill project requirements.
B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
C. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
D. All boxes containing emergency power and lighting circuits shall be identified as specified in Section 26 05 53 – Identification for Electrical Systems.
E. Provide (oil-tight) knockout closures to cap unused knockout holes where blanks have been removed.
F. Install electrical boxes in only those locations which ensure ready accessibility to enclosed electrical wiring.
G. Maximum box size in a fire-rated wall shall be 4 inches by 4 inches square. Do not install boxes back-to-back in walls. In nonfire-rated and nonacoustic- rated walls, provide not less than 6 inches (150 mm) horizontal separation between boxes installed in opposite sides of wall. Provide not less than 24 inches (610 mm) horizontal separation between boxes installed in opposite sides of fire-rated and acoustic- rated walls.
H. Do not install aluminum products in concrete.
I. Position recessed outlet boxes accurately to allow for surface finish thickness.
J. Set floor boxes level and flush with finish flooring material.
K. Fasten electrical boxes firmly and rigidly to the surfaces to which attached, structural surfaces to which attached, or solidly embed them in concrete or masonry.
L. Provide electrical connections for installed boxes.
M. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.05 GROUNDING:

A. Properly ground electrical boxes and demonstrate compliance with NEC and OESC requirements. Bond all non-isolated equipment grounding conductors to all electrical boxes.

3.06 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS:

A. Comply with NECA 1.
B. Comply with NECA VE-2 for cable tray and cable penetrations.
C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
   5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.
D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
   1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
   2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.07 SLEEVE-SEAL-SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.08 SLEEVE-SEAL-FITTING INSTALLATION:

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 33

SECTION 26 05 36 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
A. This Section specifies the following cable tray systems:
1. Ladder cable trays.

1.03 RELATED REQUIREMENTS:
A. DIVISION 1 for Substitutions, Submittals, and Closeout.
B. Section 26 05 10 – Basic Electrical Requirements
C. Section 26 05 29 – Hangars and Supports for Electrical Systems
D. Section 26 05 53 – Identification for Electrical Systems

1.04 REFERENCE STANDARDS:
A. Publication Dates: Comply with latest version of standards unless otherwise indicated.
1. American Society of Civil Engineers/Structural Engineering Institute.
a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
2. ASTM International (ASTM):
a. ASTM A240/A240M – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
b. ASTM F593: Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
c. ASTM F594 - Specification for Stainless Steel Nuts.
3. Institute of Electrical and Electronic Engineers (IEEE):
a. C2 – National Electrical Safety Code (NESC)
4. National Electrical Manufacturers Association (NEMA):
a. NEMA VE 1 - Metal Cable Tray Systems.
b. NEMA VE 2 - Cable Tray Installation Guidelines.
5. National Fire Protection Association (NFPA):
a. NFPA 70 – (2020)
6. Underwriters Laboratories (UL).

1.05 SUBMITTALS:
A. Refer to DIVISION 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
B. Product Data: Submit manufacturer’s data for each type of product indicated.
1. Include data indicating dimensions and finishes for each type of cable tray indicated.
2. Include data for all cable tray fittings.
C. Shop Drawings: For each type of cable tray.
1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
D. Coordination Drawings: Plan views and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of structure.

E. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 70ºF, ambient; 180ºF, material surfaces.

2.02 GENERAL REQUIREMENTS FOR CABLE TRAYS:

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.
B. Sizes and Configurations: See Drawings for specific requirements for types, materials, sizes, and configurations.
C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.03 LADDER CABLE TRAYS:

A. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line or comparable product by the following:
   1. MP Husky.
B. Description:
   1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
   2. Rung Spacing: 6 inches.
   3. Radius-Fitting Rung Spacing: 6 inches at center of tray's width.
   4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
   5. No portion of the rungs shall protrude below the bottom plane of side rails.
   6. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
   7. Maximum Usable Load Depth: 4 inches.
   8. Minimum Rail Heights: 5 inches.

9. Straight Section Lengths: 12 feet (min), except where shorter lengths are required to facilitate tray assembly.
10. Width: As indicated on Drawings.
11. Fitting Minimum Radius: As indicated on drawings.
12. Class Designation: Comply with NEMA VE 1, Class A (Cable Load 50 lbs/ft).
13. Splicing Assemblies: Bolted type using serrated flange locknuts.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
15. Covers: Cable tray covers are not required.

2.04 MATERIALS AND FINISHES:

A. Aluminum:
   1. Materials: Aluminum Construction.
   2. Hardware: Aluminum Construction unless strength requires another material. Use isolation material if dissimilar metals come in contact.

2.05 CABLE TRAY ACCESSORIES:

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
B. Barrier Strips: Same materials and finishes as for cable tray.
C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.06 WARNING SIGNS:

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."
B. Comply with requirements for fasteners in Section 26 05 53 - Identification for Electrical Systems.

2.07 SOURCE QUALITY CONTROL:

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.01 CABLE TRAY INSTALLATION:

A. Install cable trays according to NEMA VE 2.
B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
D. Remove burrs and sharp edges from cable trays.
E. Join cable tray with splice plates; use four square-neck carriage bolts and locknuts.
F. Fasten cable tray supports to building structure.
G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.
H. Place supports so that spans do not exceed maximum span as shown on the Drawings.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze as required by application.
J. Support tray assembly to prevent twisting from eccentric loading.
K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.
L. Make connections to structural steel members. Support cable trays independent of fittings. Do not carry weight of cable trays on non-structural members.
M. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.
N. Make changes in direction and elevation using manufacturer's recommended fittings.
O. Make cable tray connections using manufacturer's recommended fittings.
P. Install cable trays with enough workspace to permit access for installing cables.
Q. Install barriers to separate cables of different systems, such as power, communications, and data processing.
R. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.02 CABLE TRAY GROUNDING:
A. Provide cable tray fittings suitable for use as Equipment Grounding Conductor. Equipment grounding conductor size (cross sectional area of cable tray) shall correspond to the largest circuit installed in the cable tray.
B. Ground cable trays according to NEC unless additional grounding is specified.
C. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
E. Bond cable trays to power source for cables contained within, with bonding conductors sized according to NEC, Article 250.122, "Size of Equipment Grounding Conductors."

3.03 CABLE INSTALLATION:
A. Install cables only when each cable tray run has been completed and inspected.
B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
C. Fasten cables on vertical runs to cable trays every 18 inches.
D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

3.04 CONNECTIONS:
A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.05 PROTECTION:

A. Protect installed cable trays and cables.
   1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

3.06 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
   4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
   5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
   6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
   7. Check for improperly sized or installed bonding jumpers.
   8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.
   10. Prepare test and inspection reports.

END OF SECTION 26 05 36

SECTION 26 05 48 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Isolation pads.
   2. Spring isolators.
   3. Restrained spring isolators.
   4. Channel support systems.
   5. Restraint cables.
   6. Hanger rod stiffeners.
   7. Anchorage bushings and washers.

B. Related Sections include the following:
   1. Section 26 05 29 – Hangars And Supports For Electrical Systems for commonly used electrical supports and installation requirements.

1.03 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM)
   1. ASTM-A492, “Standard Specification for Stainless Steel Rope Wire”
   2. ASTM A603, “Standard Specification for Zinc-Coated Steel Structural Wire Rope”
   3. ASTM E488, “Standard Test Methods for Strength of Anchors in Concrete Elements”

B. American Welding Society
   1. AWS D1.1/D1.1M, “Structural Welding Code – Steel”.

C. International Building Code (IBC)

D. International Code Council (ICC)
   1. ICC-ES, “ICC Evaluation Services”

E. Metal Framing Manufacturers Association (MFMA)
   1. MFMA-3, “Metal Framing Standards Publication”

F. National Fire Protection Association (NFPA).
   1. NFPA 70, “National Electrical Code (NEC)”.

G. Nationally Recognized Testing Laboratory (NRTL)

H. Occupational Safety and Health Administration(OSHA)
   1. OSHA 29 CFR 1910.7, “Definition and requirements for a nationally recognized testing laboratory”.

1.04 DEFINITIONS:

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

1.05 PERFORMANCE REQUIREMENTS:

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: D.
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.

a. Component Importance Factor: 1.5.
b. Component Response Modification Factor: Per ASCE 7-05 Table 13.6-1 Seismic Coefficients for Mechanical and Electrical Components.
c. Component Amplification Factor: Per ASCE 7-05 Table 13.6-1 Seismic Coefficients for Mechanical and Electrical Components.

3. Design Spectral Response Acceleration at Short Periods 0.54 Second.
4. Design Spectral Response Acceleration at 1.0-Second Period: 0.18.

1.06 SUBMITTALS:

A. Product Data: For the following:
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
3. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other DIVISION 26 Sections for equipment mounted outdoors.
2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:
a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.
c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Qualification Data: For professional engineer and testing agency.

E. Welding certificates.
F. Field quality-control test reports.

1.07 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.
D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
   3. California Dynamics Corporation.
   4. Isolation Technology, Inc.
   5. Kinetics Noise Control.
   6. Mason Industries.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.
   9. Vibration Mountings & Controls, Inc.
B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.
C. Spring Isolators : Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50% of the required deflection at rated load.
   3. Lateral Stiffness: More than 80% of rated vertical stiffness.

4. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.02 SEISMIC-RESTRAINT DEVICES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amber/Booth Company, Inc.
   2. California Dynamics Corporation.
   3. Cooper B-Line, Inc.; a division of Cooper Industries.
   4. Hilti Inc.
   5. Loos & Co.; Seismic Earthquake Division.
   6. Mason Industries.
   7. TOLCO Incorporated; a brand of NIBCO INC.
   8. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
   1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.03 FACTORY FINISHES:

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS:

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 SEISMIC-RESTRAINT DEVICE INSTALLATION:

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
D. Drilled-in Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
B. Perform tests and inspections.
C. Tests and Inspections:
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Contractor, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Contractor’s approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90% of rated proof load of device.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.

9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.06 ADJUSTING:

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 26 05 48

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies electrical identification work including the following:
   1. Buried cable and duct bank warnings.
   2. Electrical power, control, and communication conductors (and raceways).
   3. Operational instructions and warnings.
   4. Danger, caution and warning signs.
   5. Equipment/system identification nameplates.

1.03 RELATED REQUIREMENTS:

A. Section 26 05 10 - Basic Electrical Requirements
B. Section 26 05 73 – Overcurrent Protective Device Coordination Study.
C. Section 26 05 74 – Overcurrent Protective Device Arc-Flash Study.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. Applicable Standards: Comply with the applicable requirements of the following standards.
   1. The American Society of Mechanical Engineers (ASME):
      a. A13.1 - Scheme for the Identification of Piping Systems.
   2. ASTM International (ASTM):
      a. ASTM D709 - Standard Specification for Laminated Thermosetting Materials.
   3. National Electrical Manufacturers Association (NEMA):
      a. Z535.1 – Safety Colors.
      b. Z535.4 – Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC), as applicable to installation of identifying labels and markers for wiring and equipment.
      b. 70E – Standard for Electrical Safety In The Workplace.
      c. 72 – National Electric Safety Code (NESC) – IEEE C2.
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.144 – Safety Color Code for Marking Physical Hazards.
      b. 29 CFR 1910.145 - Specifications for Accident Prevention Signs and Tags.
   6. Underwriters Laboratories (UL), pertaining to electrical identification systems:
      a. 969-1995 – Standards for Marking and Labeling Systems. - Fourth Edition; Reprint with Revisions Through and Including September 19, 2014.

1.05 SUBMITTALS:

A. Refer to Division 01 and Section 26 05 10 - Basic Electrical Requirements for administrative and procedural requirements for submittals.
B. Includes, but not limited to, the following:

1. Product Data: Submit manufacturer's data on electrical identification materials and products.
2. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

1.06 QUALITY ASSURANCE:

A. Comply with ASME A13.1 and IEEE C2.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with NEMA Z535.4 – Product Safety Signs and Labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.07 COORDINATION:

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):
1. Brady Worldwide, Inc.
2. Panduit Corp.
3. Seton Identification Products.
4. Thomas & Betts Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS:

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option; but provide single selection for each application.
B. Orange "Emergency" and “( )-VOLT" Conduit, Equipment, Box, and Cable Tray Markers:
1. General: Self-adhesive vinyl tape marker not less than 3 mils thick. Provide 1-1/8 inch wide by 4-1/2 inch long marker for 2 inch and smaller conduit. Provide 2-1/4 inch wide by 9 inch long marker for 2-1/2 inch and larger conduit and all cable tray. Except as otherwise indicated, provide black lettering which indicates highest voltage of cables(s) in conduit or cable tray. Provide black lettering that indicates "Emergency" power circuit is in conduit or cable tray.
2. Colors: Unless otherwise indicated or required by governing regulations, provide orange background tape marker.
C. Underground Type Plastic Line Marker:

1. General: Permanent, bright-colored, continuous-printed plastic tape marker, intended for direct-burial service; not less than 6 inches wide by 4 mils thick. Provide tape marker with printing which most accurately indicates type of service of buried cable or duct bank. Provide embedded continuous metallic strip or core.

D. Wire/Cable Identification Bands:
1. General: Vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either prenumbered plastic coated type or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification number indicated on Drawings or Shop Drawings.

E. Plasticized Tags:
1. General: Preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inches by 5-5/8 inches, with brass grommets and wire fasteners, and with appropriate preprinted wording, including large-size primary wording, e.g., "DANGER, DO NOT OPERATE." Tags shall comply with OSHA requirements.

F. Self-Adhesive Plastic Signs:
1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., "EXHAUST FAN."
   a. Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel "Danger" Signs:
1. "DANGER" signs of baked enamel finish on 20-gauge steel (unless specified otherwise); of standard safety red, safety black, and safety white; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "_____VOLTS, KEEP AWAY." Sign shall conform to OSHA and NEMA Z535.4.

H. Baked Enamel "Caution" Signs:
1. "CAUTION" signs of baked enamel finish on 20 gauge steel (unless specified otherwise); of standard safety yellow with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "Caution for Ear Protection Required in this Area."

I. Based Enamel "WARNING" Signs:
1. "WARNING" signs of baked enamel finish on 20 gauge steel (unless specified otherwise); of standard safety orange with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is largest size that can be applied where needed and except where larger size is needed for adequate vision; with recognized standard explanation wording. Sign shall conform to OSHA and NEMA Z535.4.

J. Engraved Plastic-Laminate Nameplates:
1. General: Engraving stock melamine plastic laminate nameplates, in sizes (minimum height of characters shall be 1/8 inch) and thicknesses specified or indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, specified or required. Colors shall comply with OSHA and NEMA Z535.1. Nameplate shall be punched for mechanical

fastening except where adhesive mounting is necessary because of surface it is mounted to.

a. Thickness: 1/16-inch, for units up to 20 square inches or 8 inch length; 1/8-inch for larger units.
b. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate surface it is mounted to.

2. Lettering and Graphics:
   a. Coordinate names, abbreviations, and other designations used in electric identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ASME A13.1 pertaining to minimum sizes for letters and numbers. Comply with OSHA and NEMA Z535.4 requirements.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. General Installation Requirements:
   1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
   2. Coordination: Where identification is to be applied to surfaces which require finish painting, install identification after completion of painting.
   3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Branch Circuit Panelboards
   1. Indicate panel number, source, and if applicable, transformer number from which the panel is fed with laminated plastic labels attached to face trim. Indicate feeder source, feeder wire size, and feeder breaker or fuse size with laminated plastic labels on the inside of the panel door.
   2. Provide typewritten or power system software generated panel directories, with protective, clear transparent covers, accurately accounting for every breaker installed, including spares. Schedules shall use the actual loads and room designations assigned by name or number near completion of the work. Do not use the designations from the drawings.

C. Motor Control Enclosures
   1. Label all starters and breakers with factory-provided labels or laminated plastic labels indicating the function or the load served and location.

D. Transformers
   1. Label all transformers with laminated plastic labels indicating equipment number, source, and load.

E. Equipment
   1. Label all disconnect switches, individual circuit breakers, security and communications panels, relays, contactors, time switches, and indicating equipment with laminated plastic labels indicating equipment number, source, and circuit number.
   2. Where the controlling device is remote-mounted from the serving panel, include the serving panel designation and circuit number with additional plastic tape labels.

F. Devices
   1. All receptacle plates shall be marked in black permanent marker tape on the face of the plate, with the receptacles panel and branch circuit designation. The identification shall be made with clear self-adhesive tape with black 10-point letters. Apply the tape at the top of the device plate.
   2. Receptacles connected to a GFCI-protected circuit downstream from the protecting device shall be labeled "GFCI Protected."

G. Conduit and Cable
   1. Label all conduit runs. Space labels a maximum of 50 feet apart. Place at entrances of all "J" boxes, Wireways, distribution panels, MCC, panelboards, end devices etc.
   2. Use laminated plastic labels as shown in the attached labeling detail.

H. Outlet, Pull, and Junction Boxes
   1. Paint fire alarm and security access system outlets, pull, and junction boxes in accordance with the directions of their specific sections.
   2. Label all pull boxes and junction boxes for fire alarm, security, surveillance, and communications systems with plastic tape, red with white letters. Where boxes are recessed in finished areas, mount label on inside of cover.
   3. Label power junction boxes neatly by hand, indicating source and circuit number.

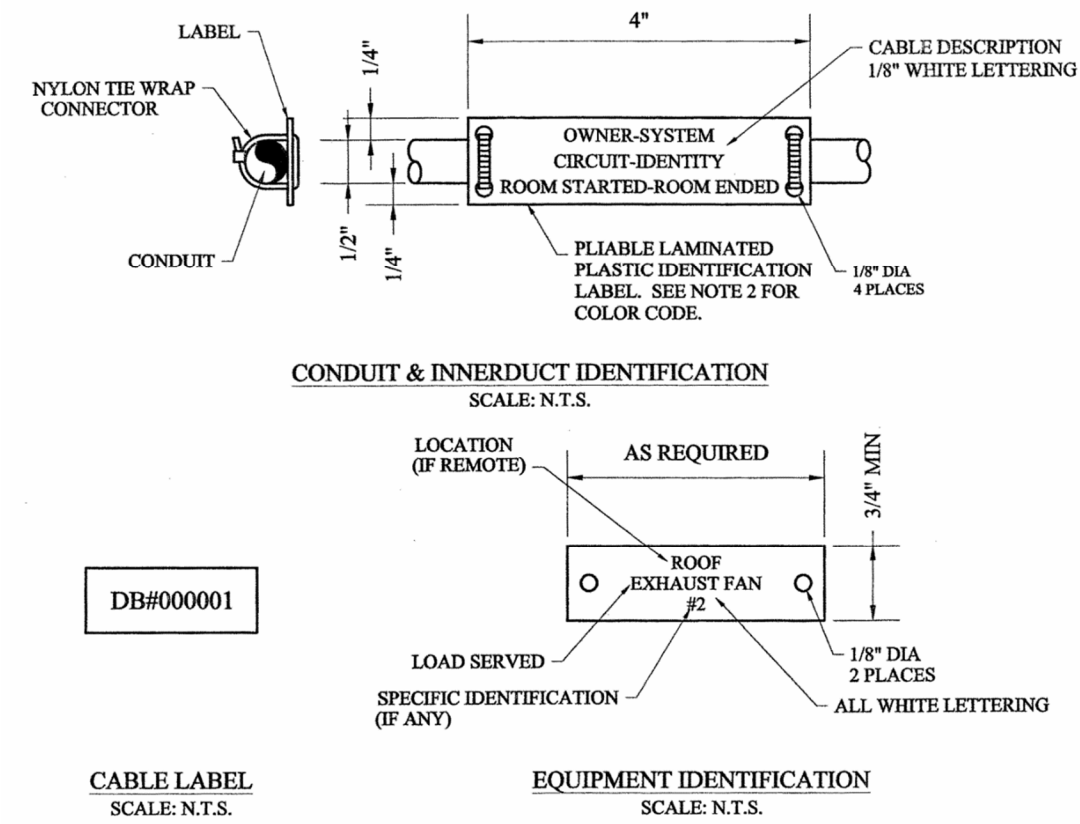
I. Conduits Exiting Underground Vaults
   1. At each conduit entry and exit through an interior vault wall, provide an engraved brass label and fill the letters with contrasting enamel paint. The label shall identify each conduit and where it terminates. For example, the top northern conduit would be labeled "#1 to CVLTx," where CVLTx is the end-point for that conduit run. The next lower conduit would be labeled sequentially as "#2 to CVLTx," etc.
   2. Provide corresponding labels at both ends of each conduit run including conduits that extend through interior walls of vaults, structures, or buildings.
   3. Place the labels on the wall adjacent to each conduit. Secure the labels into the concrete with stainless steel screws and wall anchors that allow the label to be replaced if necessary.

J. System
   1. Complex control circuits may utilize any combination of colors with each conductor identified throughout, using wrap-around numbers or letters. Label all wiring per the circuit schedule identified within drawings. Label the fire alarm and communication equipment zones, controls, indicators, etc., with pre-printed labels or indicators appropriate for the equipment installed, as supplied or recommended by the equipment manufacturer.
   2. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

K. Arc Flash Labels
   1. A minimum of 4 weeks prior to anticipated substantial completion, submit the following information so that the Port can create arc flash labels for newly installed equipment:
      a. Feeder sizes for each piece of equipment including feeder type, length, configuration, and raceway type in which feeder is installed.
      b. Overcurrent protection equipment brand name, model number, and any breaker settings and/or fuse sizes. Provide information for all overcurrent devices including Port-owned equipment feeding new feeders and newly installed equipment.
      c. Equipment AIC rating.

2. The Subcontractor shall install labels furnished by the Port.

PORT STANDARDS FOR ELECTRICAL EQUIPMENT IDENTIFICATION



NOTES:
1. Use laminated labels at all interior and protected locations. Use professionally engraved, white enamel filled brass labels in all areas exposed to the weather and/or sunlight, and in environment air handling spaces.
2. Color code for labels shall be as follows:

Port	Blue
FAA	Yellow
Airlines	Green
Telco	Red
Other Tenants	Black
Emergency	White with Red Letters

3. Install conduit and innerduct labels at each end of the conduit run, at entrances of all duct banks, distribution panels, motor control centers, panel boards, etc. Provide a minimum of one label per room or space.
4. Install equipment labels with stainless steel #4 screws.

5. System examples: Power, Fire Alarm, HVAC, Communications, Signal, Telephone, Revenue Control
6. Label cables with preprinted label. Labels shall wrap around and shall have a reference number. At a minimum, label the cable at the cable start and end terminals, at intermediate points in runs where cable leaves a cable tray, and at all intermediate junction boxes and lay down locations.7. Complete installation of labels prior to ceiling installation.

L. Operational Identification and Warning Plasticized Tags and Metal Signs and Plastic Signs:
   1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install signs with instruction or warnings. When signs are installed on switches, outlets, controls, devices and covers of electrical enclosures they may be self-adhesive vinyl or plastic. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

M. Danger Signs:
   1. General: In addition to installation of danger signs specified, indicated, and required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about Project.
   2. XXXX Volts: Install danger signs (with actual circuit voltage) on all building doors, substations, switchgear, switchboards, panelboards switches, circuit breakers, etc., wherever it is possible (under any circumstances) for persons to come into contact with electrical voltages to ground greater than 277V.

3. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons or damage to or loss of property.
4. Provide the following danger sign on the equipment indicated:
   a. "Danger This Machine Starts Automatically" on all fire pumps, air compressors and emergency generators.
5. Provide the following danger signs on the doors leading to the equipment indicated:
   a. "Danger Hearing Protection Required" on all emergency generator room doors.
   b. "Danger: No Smoking, Matches or Open Flames" on all emergency generator room doors.

N. Warning Signs:
1. Provide an orange background sign with black letters reading "WARNING: LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED" on all tie switches and tie circuit breakers.
2. Provide cable tray warning signs with 1-1/2-inch high black letters on an orange background that reads: "Warning! Not to be used as a walkway, ladder or support for ladders for personnel." Provide on each side of cable tray at 10-foot intervals, visible from the floor below.
3. Provide Arc Flash Warning signs on electrical equipment such as switchboards, switchgear, panelboards, transfer switches, industrial control panels, motor control centers and meter socket enclosures that are likely to require examination, adjustment, servicing, or maintenance while energized. Marking shall be permanently affixed and of a durable nature to withstand the environment within which it is installed.
4. Provide Available Fault Current and Arc Flash Warning signs on electrical equipment as specified in Section 26 05 73 and Section 26 05 74. Label shall include possible incident energy exposure within arc flash boundary in front of equipment as well as meet NFPA 70E for additional content.

O. Caution Signs:
1. Provide yellow background caution signs with black letters on the doors leading to the equipment indicated:
   a. "Caution Ear Protection Required in this Area" on all emergency generator room doors.
2. Provide the following yellow background caution sign with black letters on all panelboards, substations, switches, circuit breakers, and switchboards where turning off a circuit will automatically start an emergency generator:
   a. "Caution Turning Off this Circuit will Automatically Start Emergency Generator XX"
3. Provide the following yellow background caution sign with black letters on all automatic transfer switches, switches, circuit breakers, equipment, and emergency panelboards that are energized by the emergency power system:
   a. "Caution Automatically Energized by the Emergency Power System."

END OF SECTION 26 05 53

SECTION 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 OVERCURRENT PROTECTIVE DEVICE STUDY PROVIDER:

A. Subject to compliance with requirements, provide an updated and complete computer-based coordination study. Update the computer-based coordination study from project #114425 (Phase 1). The study shall include, at minimum, the addition of the operations building and any other modifications to the existing one-line.

1.03 SUMMARY:

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
   1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.04 REFERENCE STANDARDS:

A. Code of Federal Regulations (CFR):
   1. 29 CFR 1910.7 - National Recognized Testing Laboratories.

B. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants (the Red Book)
   2. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings (The Gray Book)
   3. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (the Buff Book).
   4. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis (the Brown Book) (ANSI).
   5. IEEE 551 - Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.
   6. IEEE 620 - Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   7. IEEE C37.40 - Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.
   8. IEEE C57.12.00 - General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers (ANSI).
   9. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers (ANSI).

C. Insulated Cable Engineers Association, Inc. (ICEA):
   1. ICEA P-32-382 - Short-Circuit Characteristics of Insulated Cables.
   2. ICEA P-45-482 - Short-Circuit Performance of Metallic Shielding & Sheaths.

D. InterNational Electrical Testing Association (NETA):
   1. NETA Acceptance Testing Specification - Acceptance Testing Specifications.
   2. NETA ETT-2000 - Standard for Certification of Electrical Testing Technicians (ANSI).

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA MG 1 - Motors and Generators.
F. NFPA:
   1. NFPA 70 - National Electrical Code.
   2. NFPA 70E - Standard for Electrical Safety in the Workplace.
   3. OESC – Oregon Electrical Specialty Code
G. Underwriters Laboratories Inc. (UL):
   1. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

1.05 SUBMITTALS:

A. Product Data: For computer software program to be used for studies.
B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.
   4. Software model file.
C. Qualification Data: For coordination-study specialist.
D. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.06 QUALITY ASSURANCE:

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
   1. Professional Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of Engineer.
C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS:

A. Available Computer Software Developers: Subject to compliance with requirements, provide software model by the following:
   1. SKM Systems Analysis, Inc., Power Tools for Windows (PTW)
   2. ETAP Electrical Power System Analysis & Operation Software
   3. EasyPower Power System Software

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS:

A. Comply with IEEE 399.
B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
   1. Optional Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.
      d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA:

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
   2. Impedance of utility service entrance.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings and types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.
   4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
      d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY:

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Switchgear and switchboard bus.
   2. Motor-control center.
   3. Distribution panelboard.
   4. Branch circuit panelboard.
B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241, and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Medium-Voltage Circuit Breakers: IEEE C37.010.
   3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   4. Low-Voltage Fuses: IEEE C37.46.
E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
   2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
F. Equipment Evaluation Report:
   1. For 600V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY:

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141, IEEE 241, and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
   1. Device shall not operate in response to the following:
      a. Inrush current when first energized.
      b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
      c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
   2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
      c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
      d. Fuse-current rating and type.
      e. Ground-fault relay-pickup and time-delay settings.
   2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
      a. Device tag.
      b. Voltage and current ratio for curves.
      c. Three-phase and single-phase damage points for each transformer.
      d. No damage, melting, and clearing curves for fuses.
      e. Cable damage curves.

f. Transformer inrush points.
g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.05 BREAKER SETTING ADJUSTMENTS

A. Adjust all breakers and relays in accordance with completed data sheets.

END OF SECTION 26 05 73

SECTION 26 05 74 – OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY PROVIDER:

A. Subject to compliance with requirements, Subcontractor shall provide a complete computer-based arc-flash study for this project based upon the electrical distribution components provided by Subcontractor under this project.

1.03 SUMMARY

A. Section includes computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.04 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
D. SCCR: Short-circuit current rating.
E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.05 ACTION SUBMITTALS

A. Product Data: Provide a statement of the specific version of SKM PTW, EasyPower or ETAP computer software program to be used for studies.
B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form plus six hard copies.
    1. Arc-flash study input data, including completed computer program input data sheets.
    2. Arc-flash study computer model including all device files.
    3. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
        a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Owner for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.06 CLOSEOUT SUBMITTALS

A. In addition to the digital copy of the report provide a digital “Backup” copy of the computer based model.

1.07 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

B. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located and with minimum of 6 years' experience in performing arc flash hazard studies using the software. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

C. Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) and that is acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Manufacturer: Subject to compliance with requirements, provide software model by the following:
   1. SKM Systems Analysis, Inc., Power Tools for Windows (PTW)
   2. ETAP Electrical Power System Analysis & Operation Software
   3. EasyPower Power System Software

B. Analytical features of device coordination study computer software program shall have the capability to calculate the arc flash hazard in cal/sq-cm using IEEE-1584 methodology.

2.02 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary.

B. Study descriptions, purpose, basis, alternate scenarios of operation, and scope.

C. Computer produced One-line diagram for normal utility power distribution, showing the following:
   1. Buses in distribution system at connection points and after impedance components.
   2. Protective device designations, manufacturer, ampere ratings, and settings.
   3. Cable size and lengths.
   4. Transformer kilovolt ampere (kVA), voltage ratings and %Z.
   5. Motor and generator designations and kVA ratings.
   6. Switchgear, switchboard, motor-control center and panelboard designations.

D. Protective Device Coordination Study Report Contents: As specified in “Protective Device Coordination Study Report Contents" Article in Section 26 05 73 – Overcurrent Protective Device Coordination Study.

E. Arc-Flash Study Output:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. Equivalent impedance.

e. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

F. Incident Energy and Arc Flash Boundary Calculations:
1. Arcing fault magnitude.
2. Voltage of Equipment.
3. Duration of arc.
4. Arc-flash boundary.
5. Working distance, as 18 inches unless agreed to by both engineer and owner.
6. Incident energy.
7. Level of PPE (Personal Protection Equipment).
8. Recommendations for arc-flash energy reduction.

G. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.03 ARC-FLASH WARNING LABELS

A. Produce a 4 by 6 thermal transfer label of high-adhesion vinyl for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH and Shock HAZARD – Appropriate PPE Required," and shall include the following information taken directly from the arc-flash hazard analysis: (Label format to be agreed on by engineer and owner.)
1. Location designation.
2. Nominal voltage.
3. Arc Flash boundary.
4. Level of PPE.
5. Working distance.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.02 ARC-FLASH HAZARD ANALYSIS

A. Comply with IEEE-1584, NFPA 70E and its Annex D for arc flash hazard analysis study.

B. Preparatory Studies:
1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73 – Overcurrent Protective Device Short-Circuit Study.
2. Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 26 05 73 – Overcurrent Protective Device Coordination Study.

C. Calculate maximum and minimum contributions of fault-current size as follows:

1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
2. The normal calculation shall include normal utility feeds to the facility.
3. The generator calculation shall provide for contribution from the switchyard and local standby emergency generators in lieu of utility feed.
4. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
5. The reduced utility source calculation shall assume the loss of a utility feed and the transfer of those loads to another utility feed.

D. Calculate the arc-flash boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 112.5 kVA or smaller.

F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:
1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2 for equipment where personnel can remove themselves from the event.

3.03 POWER SYSTEM DATA

A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
1. Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Owner.
2. For new equipment, use characteristics submitted under the provisions of action submittals from manufacture's and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or

its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use descriptive equipment designation tags that are consistent with electrical distribution system diagrams and owners choosing and not simple alphanumeric nomenclature, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility nominal voltage, available short circuit current plus X/R ratio for three phase and single phase to ground impedance at the service, include grounding configuration and utility provided overcurrent protection.
3. Power sources and ties.
4. Short-circuit current at each system bus, three phase and line-to-ground.
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
13. Motor horsepower, voltage, full load amperes, service factor for motors 50hp and larger.
14. Low-voltage cable sizes, lengths, number, conductor material and conduit material
15. (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.04 LABELING

A. Apply one arc-flash label for Medium Voltage Equipment, 600-V ac and 480-V ac panelboards and applicable disconnects and for each of the following locations:
   1. Motor-control centers.
   2. Low-voltage switchboards and power panels.
   3. Switchgear.
   4. Medium-voltage switchgear, switches, and MCC's.
   5. Control panels fed by circuits 60A or larger.

3.05 APPLICATION OF WARNING LABELS

A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

3.06 DEMONSTRATION

A. Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

END OF SECTION 26 05 74

SECTION 26 29 23 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes requirements for design, construction, performance, inspection, shipment, and documentation of 600VAC and less, 3-phase, variable-frequency drives (VFD) for squirrel cage induction motors.

1.03 RELATED REQUIREMENTS:

A. Section 26 05 10 - Basic Electrical Requirements.

1.04 DEFINITIONS

A. CE: Conformite Europeenne (European Compliance).
B. CPT: Control power transformer.
C. DDC: Direct digital control.
D. EMI: Electromagnetic interference.
E. LED: Light-emitting diode.
F. NC: Normally closed.
G. NO: Normally open.
H. OCPD: Overcurrent protective device.
I. PID: Control action, proportional plus integral plus derivative.
J. RFI: Radio-frequency interference.
K. VFD: Variable-frequency drive.

1.05 REFERENCES:

A. Applicable Standards: Comply with applicable requirements of the following standards.
    1. Institute of Electrical and Electronic Engineers (IEEE)
        a. 519 – Guide for Harmonic Control and Reactive Compensation of Stative Power Converters
        b. 1100 – Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
    2. International Code Council (ICC)
        a. IBC – International Building Code
    3. National Electrical Manufacturers Association (NEMA):
        a. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
        b. ICS 1 - Standard for Industrial Control and Systems: General Requirements.
        c. ICS 6 - Enclosures.
        d. ICS 7 - Adjustable-Speed Drives.
    4. National Fire Protection Association (NFPA):
        a. 70 (2017) - National Electrical Code.
        b. OESC – Oregon Electrical Specialty Code (based on NFPA 70)
    5. Underwriters Laboratories (UL):
        a. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
        b. 508C - Power Conversion Equipment.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 EXAMINATION

A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Seismic Bracing: Comply with requirements specified in Section 26 05 48 – Vibration And Seismic Controls For Electrical Systems."
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
C. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
D. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
E. Comply with NECA 1.

3.03 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and Fuel Control System PLC. Comply with requirements in Section 26 05 23 – Control-Voltage Electrical Power Cables.
B. Bundle, train, and support wiring in enclosures.
C. Connect selector switches and other automatic-control devices where applicable.
    1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
    2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.04 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 – Identification for Electrical Systems.
    1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
    2. Label each VFD with engraved nameplate.
    3. Label each enclosure-mounted control and pilot device.

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform tests and inspections with the assistance of a factory-authorized service representative.
C. Acceptance Testing Preparation:
    1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
    2. Test continuity of each circuit.
D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Contractor before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
7. Perform infrared (thermographic) scan tests and inspections, and prepare reports:

E. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFDs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Submit all meter readings and field test results.

3.07 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

3.08 DEMONSTRATION

A. Provide 8 hours of on-site training, divided among two different shifts, to Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 26 29 23

SECTION 26 41 13 – LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes lightning protection for structures.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. NFPA

1. NFPA 780-2014: Standard for the Installation of Lightning Protection Systems (ANSI)

C. Underwriters Laboratories Inc.

1. UL 96-2005: Lightning Protection Components (ANSI)
2. UL 96A-2007: Installation Requirements for Lightning Protection Systems (ANSI)

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.
2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

D. System Certificate and Label: Written verification of passed inspection as outlined in Section 3.04 – Field Quality Control.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications: Certified by UL or Lightning Protection Institute as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label or LPI-IP Master Certificate

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.06 COORDINATION:

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer. Install in a manner approved by roof manufacturer such that roof warranty is maintained.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS:

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class II, copper unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. East Coast Lightning Equipment Inc.
   b. ERICO International Corporation.
   c. Harger.
   d. Heary Bros. Lightning Protection Co. Inc.
   e. Independent Protection Co.
   f. Preferred Lightning Protection.
   g. Robbins Lightning, Inc.
   h. Thompson Lightning Protection, Inc.

C. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

1. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials.

D. Main and Bonding Conductors: Copper.

E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.

D. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

E. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

F. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

G. Bury ground ring not less than 24 inches from building foundation.

1. Bond ground terminals to the ground loop.

H. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

3.02 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS:

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 33 – Raceways, Boxes, Sleeves, Seals and Fittings for Electrical Systems.

3.03 CORROSION PROTECTION:

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL:

A. Notify Contractor at least 48 hours in advance of inspection before concealing lightning protection components.

B. Provide one of the following:

1. UL Inspection: Meet requirements to obtain a UL Master Label for system.
2. LPI System Inspection: Meet requirements to obtain an LPI-IP Master Certificate.

END OF SECTION 26 41 13

SECTION 26 56 10 – EXTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies exterior lighting fixture work as indicated by drawings, schedules, and as specified herein.

B. Types of exterior lighting fixtures and associated equipment in this Section include the following:
   1. Light-Emitting Diode (LED).
   2. Steel Poles.

C. Applications of exterior lighting fixtures required for this Project include the following:
   1. Fuel Facility Area Lighting.

1.03 REFERENCE STANDARDS

A. Applicable Standards: Comply with applicable requirements of the following standards.
   1. Institute of Electrical and Electronic Engineers (IEEE):
      a. C2 – National Electrical Safety Code (NESC)
   2. National Electrical Manufacturers' Association (NEMA): Comply with applicable requirements of NEMA Stds Pub/No. LE2 pertaining to lighting equipment.
   3. National Fire Protection Association (NFPA):
      a. NFPA 70 – (2019) California Electrical Code (CEC).
   4. Underwriters Laboratories (UL): Provide exterior lighting fixtures and components which are UL listed and labeled.
      a. UL 1598
      b. UL 8750

1.04 SUBMITTALS

A. Refer to Section 26 05 10 – Basic Electrical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit manufacturer's product data and installation instructions on each type of exterior LED fixture, steel pole, and mounting equipment.

C. Maintenance Data: Submit maintenance data and parts list for each exterior LED lighting fixture and accessory, including "troubleshooting" maintenance guide. Include in this data, product data and shop drawings in a maintenance manual in accordance with requirements of Division 01.

1.05 QUALITY ASSURANCE

A. IES LM-79 and LM-80 test reports are not required if Subcontractor uses basis of design fixture, where indicated in Electrical Drawing Set.

B. LED Luminaire – IES LM-79 Test Report
   1. Submit test report on manufacturer’s standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under “14.0 Test Report” in IES LM-79.

C. LED Light Source – IES LM-80 Test Report
   1. Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:
      a. Testing agency, report number, date, type of equipment, and LED light source being tested.
      b. All data required by IES LM-80.

D. Test Laboratories
   1. Test laboratories for the IES LM-79 and IES LM-80 test reports shall be one of the following:
      a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.
      b. A manufacturer's in-house lab that meets the following criteria:
         (1) A manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires and the manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years
         (2) Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Exterior LED Fixtures:
   1. Deliver exterior LED lighting fixtures in factory-fabricated containers or wrappings which properly protect fixtures from construction debris and physical damage.
   2. Store exterior LED fixtures in original wrappings in a clean dry space. Protect from weather, dirt, fumes, water, construction debris, and damage.
   3. Handle exterior LED lighting fixtures carefully to prevent damage, breaking, and scoring. Do not install damaged fixtures or components; remove units from Site and replace with new.

B. Steel Poles:
   1. Do not store poles on ground. Support poles so they are at least 1 foot above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

1.07 SEQUENCING AND SCHEDULING

A. Sequence exterior LED lighting installation with other work to reduce possibility of damage and soiling of fixtures during the remainder of construction period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following (for each type of exterior LED lighting fixture):
   1. Exterior LED Fixtures:
      a. Appleton Electric Co.
      b. Cooper Lighting Solutions.
      c. Eaton Corp.
      d. Dual-Lite Mfg. Inc.

e. General Electric Co.
f. GTE Sylvania, Inc.
g. Hubbell, Inc.
h. Lithonia Lighting Div; National Services Industries, Inc.
i. Philips, Gardco
j. Sylvania.
k. Wide-Light Corp.

2.02 EXTERIOR LIGHTING FIXTURES

A. General: Provide lighting fixtures of sizes, types, and ratings indicated; complete with, but not limited to, housings, LED drivers, and wiring. Provide luminaires complete with light sources of quantity, type, and wattage indicated. All equipment and materials shall bear the UL label.

2.03 LIGHT EMITTING DIODE (LED) FIXTURES

A. General Requirements:
1. LED luminaire housings shall be as indicated or manufacturer's standard if not indicated in drawing set.
2. LED luminaires shall be rated for operation with an ambient temperature range of minus 22 degrees F to 104 degrees F.
3. Luminaires shall be UL listed for wet locations per UL 1598.
4. Luminaires to be installed in hazardous locations shall be suitable for the area classification type (e.g. Class I, Division 1, Group D) and conform to UL 844 or have a Factory Mutual certification for the class and division indicated.
5. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule.
6. Housing finish shall be as indicated or manufacturer's standard if not indicated in drawing set. Marine rated fixtures shall have a finish capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.
7. Luminaires shall not exceed the following IES TM-15 Backlight, Uplight, and Glare (B.U.G.) ratings:
   a. Maximum Backlight (B) rating shall be determined by lighting zone in which luminaire is placed.
   b. Maximum Uplight (U) rating shall be U0.
   c. Maximum Glare (G) rating shall be determined by lighting zone in which luminaire is placed.
8. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.
9. The finish color shall be as indicated in the luminaire schedule or detail on the Project Plans.
10. Luminaire arm bolts shall be 304 stainless steel or zinc-plated steel.
11. Luminaire lenses shall be constructed of clear or frosted tempered glass or UV-resistant acrylic.
12. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

13. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distribution agent will not be acceptable.
14. Luminaires shall have an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled in accordance with ANSI C136.3.
15. Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.
16. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

B. LED Light Sources:
1. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:
   a. Nominal CCT: As indicated.
2. Color Rendering Index (CRI) shall be:
   a. Greater than or equal to 70 for light sources.
3. Color consistency:
   a. Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

C. LED Power Supply Units (Drivers)
1. UL1310. LED Power Supply Units (Drivers) shall meet the following requirements:
   a. Minimum efficiency shall be 85 percent.
   b. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.
   c. Shall be rated to operate between ambient temperatures of minus 22 degrees F and 104 degrees F.
   d. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.
   e. Operating frequency shall be: 50 or 60 Hz.
   f. Power Factor (PF) shall be greater than or equal to 0.90.
   g. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.
   h. Shall meet requirements of 47 CFR 15, Class B.
   i. Shall be RoHS-compliant.
   j. Shall be mounted internal to luminaire. Remote mounting of power supply is not allowed.
   k. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.
   l. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

D. LED Luminaire Surge Protection
1. Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

E. LED Luminaire Emergency Power Supply
1. Provide integral emergency power supplies for fixtures indicated.
2. Emergency power supplies shall be capable of supplying continuous power to fixture for a minimum of 90-minutes during a power failure.
3. Include a manual test switch/button and/or LED indicator light for monitoring fixture emergency power supply status without uninstallation.

2.04 STEEL POLES

1. AASHTO LTS. Provide poles designed for wind loading per contract drawings, determined in accordance with AASHTO LTS while supporting the weight and effective projected area of all luminaires and appurtenances installed.
2. Provide black-painted steel poles having minimum 7-guage steel with minimum yield/strength of 55,000 psi and hot-dipped galvanized in accordance with ASTM A123/A123M factory finish. The effective projected areas of luminaires and appurtenances used in calculations shall be specific for the actual products provided on each pole.
3. Provide a pole grounding connection designed to prevent electrolysis when used with copper ground wire.
4. Pole shall have a minimum 2.5” x 5” rectangular handhole(s) located approximately 1’-6” above base. Provide handhole with a swing latch cover assembly fabricated of polycarbonate/ABS plastic blend.
5. Pole shall be anchor bolt mounted type. Poles shall have tapered tubular members, either round in cross section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved.
6. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, and length.
7. Base covers for steel poles shall be structural quality hot-rolled carbon steel plate having a minimum yield of 36,000 psi.
8. Provide anti-vibration dampers.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which lighting fixtures are to be installed and the substrate which will support lighting fixtures. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Exterior LED Lighting Fixtures:
   1. Install exterior LED lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
   2. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torqueing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and the National Electrical Code.
   3. Fasten electrical LED lighting fixtures and brackets securely to structural supports ensure that installed fixtures are plumb and level.
   4. All exterior LED lighting shall be demonstrated during night-time tests.

5. All light fixtures which can be aimed shall be aimed as indicated and shall be re-aimed as directed by Authority Representative during night time lighting demonstrations. Demonstrate lighting at night after all adjustments have been made.

B. Steel Poles:

1. Provide pole foundations with galvanized steel anchor bolts, threaded at the top end and bent 90 degrees at the bottom end. Provide ornamental covers to match pole and galvanized nuts and washers for anchor bolts. Thoroughly compact backfill with compacting arranged to prevent pressure between conductor, jacket, or sheath and the end of conduit ell. Adjust poles as necessary to provide a permanent vertical position with the bracket arm in proper position for luminaire location. After installation, paint exposed surfaces of steel poles with two finish coats of black exterior oil paint. Install according to pole manufacturer's instructions. Alterations to poles after fabrication will void manufacturer's warranty and shall not be allowed.

3.03 GROUNDING

A. Provide equipment grounding connections for exterior LED lighting fixtures as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.

B. Provide grounding for steel poles as indicated.

3.04 ADJUSTING AND CLEANING

A. Aim adjustable lighting fixtures and lamps in night test of system. Verify that measured illuminance values comply with submitted isolux plot diagram values.

B. Clean lighting fixtures of dirt and debris upon completion of installation.

C. Protect installed fixtures from damage during construction period.

3.05 FIELD QUALITY CONTROL

A. Replace defective and burned out LED fixtures for a period of one year following the Date of Substantial Completion.

B. At the Date of Substantial Completion, replace LEDs in exterior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing as judged by Authority Representative.

3.06 DEMONSTRATION

A. Upon completion of installation of exterior LED lighting fixtures and associated electrical supply circuitry, apply electrical power to circuitry to demonstrate capability and compliance with requirements. All exterior lighting demonstrations shall be performed at night. Verify light fixture grouping (verify circuiting as indicated on Drawings) and controls. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 56 10

SECTION 27 05 53 – IDENTIFICATION FOR TELECOMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. This section describes labeling requirements for a complete telecommunications system, including the following.
   1. Horizontal link/cable.
   2. Telecommunication outlets.
   3. Telecommunications hardware.
   4. Riser/backbone cable.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 26 05 53, Identification for Electrical Systems

B. Section 27 10 00, Structured Cabling

PART 2 - PRODUCTS

2.1 LABELS

A. Pre-Printed: Permanent material pre-printed with black on white, with adhesive backing. Brady, 3M, or equal. No Dymo-tape or hand-written labels will be allowed. For use at the following locations:
   1. Telecommunication outlet faceplates.
   2. Individual horizontal cables.
   3. Rack-unit (RU) identification of network room equipment racks.
   4. Fiber optic distribution units (FODU).
   5. Protector blocks.

B. Laminated Plastic: 3-ply laminated plastic, professionally engraved. Use white enamel filled brass labels in all areas exposed to weather and/or sunlight, and in environmental air handling

spaces. Font shall be Arial capital letters. Attach labels using appropriate adhesive glue and/or nylon tie wrap connectors. Required sizes and colors are as follows:

1. Network Room Equipment Racks: 1-inch high and 5-inches long with a white background and 1/2-inch high black letters.
2. Riser/Backbone Cable: 1-inch high and 4-inches long with a blue background and 1/8-inch high white letters. The label shall have two lines. The first line shall read “Port Telco.” The second line shall indicate the appropriate cable identifier.

PART 3 - EXECUTION

3.1 LABEL INSTALLATION

A. Horizontal Link/Cable:
   1. Label each horizontal link/cable at the rear of both the outlet and patch panel locations using the appropriate cable name as indicated.
   2. At the outlet location, label the cable at 2 inches from the termination point. This will be visible by removing the outlet cover.
   3. At the patch panel location, label the cable on a visible part of the cable within 4 inches of the termination point.

B. Telecommunication Outlet Faceplates:
   1. Label each faceplate appropriately as indicated. Affix the label to the labeling area at the top of the faceplate.
   2. The port ID area of the faceplate shall reflect the equipment row, network rack number, patch panel ID and patch panel port number.

C. Riser/Backbone Cable:
   1. Every fiber optic and copper riser/backbone cable sheath shall be labeled with the appropriate cable name.
   2. Where cables are placed in an exposed manner, labels shall be placed at a minimum of every 100 feet. If a room is utilized as a routing space, the cable shall be labeled where it enters and exits the room.
   3. Cables shall be labeled at entrances to, or exits from, cable trays, riser sleeves, duct banks, junction boxes, and on both sides of a splice point.

D. Network Rack:
   1. Each network rack shall be labeled with plastic laminated labels indicating the rack number. Affix the label at the top/middle of the rack.
   2. Each patch panel and/or termination block mounted within each rack shall be labeled with pre-printed labels. The label designation shall indicate the alphabetic character that represents the associated RU number of the equipment being placed. Mount the label on the left most rack rail immediately adjacent to the top left corner of the patch panel/termination block that is being identified.

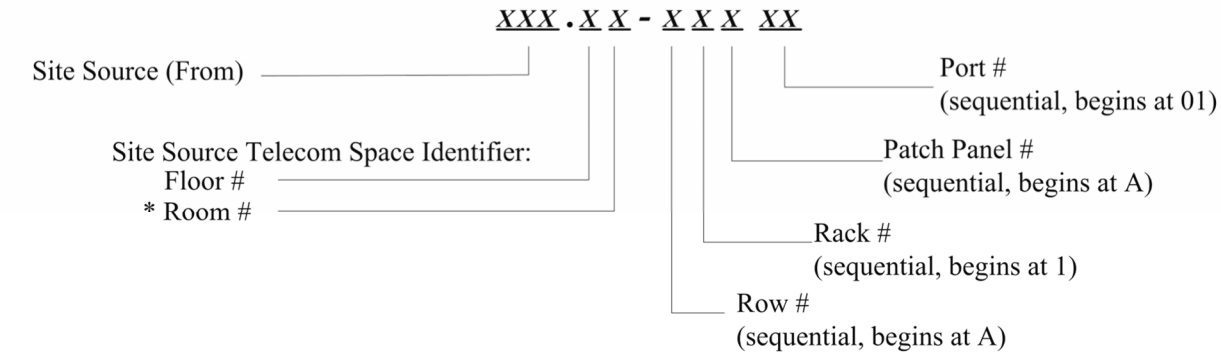
E. FODU/Termination Block:
   1. Label each FODU/termination block on its front surface with the appropriate cable name relative to the fiber optic and/or copper cable terminated on the unit.

2. Affix the fiber optic cable name label to the FODU on the bottom left-hand corner of the unit's front panel. Where more than one cable is terminated in the FODU the subsequent cable name labels will be placed so that they align above each other.
3. Affix the cable name label to the termination block on the top left-hand corner of the block's terminal strip cover.

3.2 LABEL NAMING CONVENTION

A. Horizontal Link/Cable

Example: **TRM.3X-A5B01**

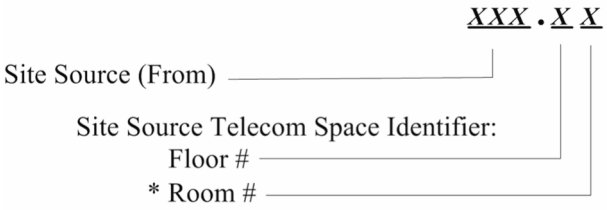


* Confidential; Provided by Port for specific construction activity

B. Telecommunication Outlet Faceplate Label

1. For the labeling area at the top of the faceplate:

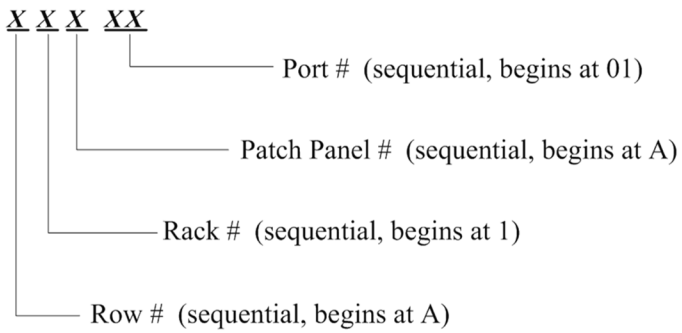
Example: **TRM.3X**



* Confidential; Provided by Port for specific construction activity

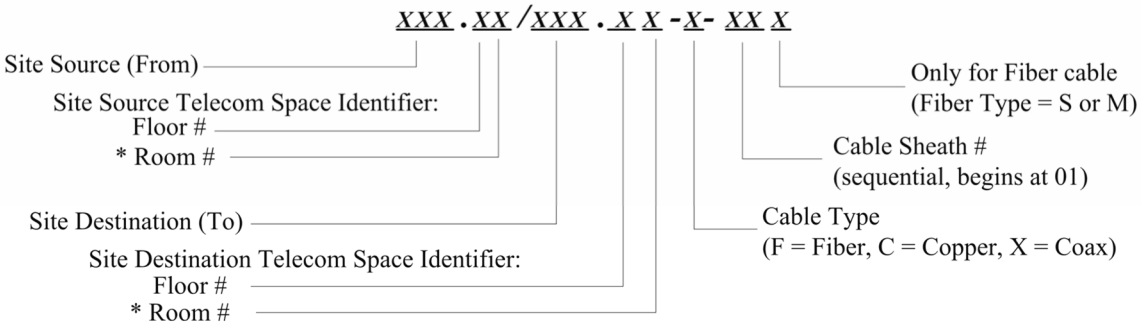
2. For the port ID area of the faceplate:

Examples: 4-port faceplate, **A5B01**, **A5B02**, **A5B03**, **A5B04** (each a minimum of 5 digits)



C. Riser/Backbone Cable (No Splice Case)

Example: **TRM.1X/TRM.3X-F-01M**



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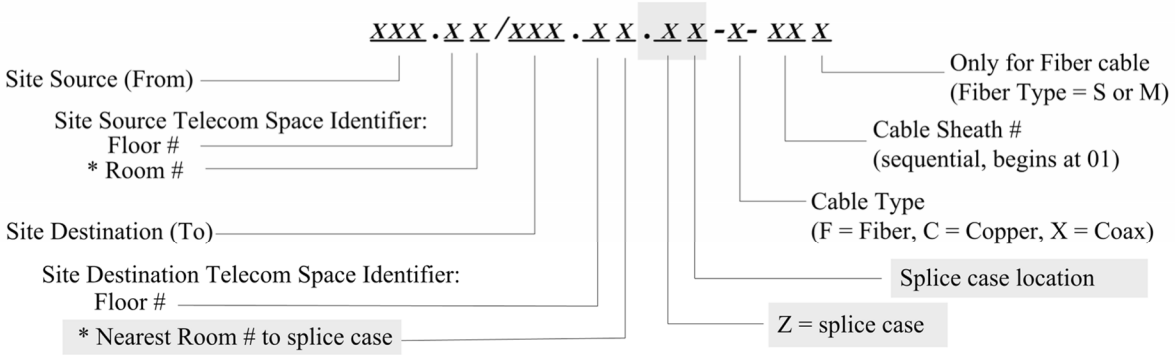
D. Riser/Backbone Cable Identifier w/ Splice Case

Example: TRM.1X/TRM.**3X.Z1**-F-01M



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3.3 SITE IDENTIFIERS

A. PDX

Site Name	Abbreviation
Fire Dept / ARFF	AFD
Airfield Gate	AFG
Airport Way	APW
Bus Offices	BOF
Concourse A	CCA
Concourse B	CCB
Concourse C	CCC
Concourse D	CCD
Concourse E	CCE
Commercial Roadway Lower	CML
Commercial Roadway Upper	CMU
SIDA Checkpoints	CPS
Construction Trailers	CTR
Central Utility Plant	CUP
Deicing Pump Stations	DPS
Fiber Hub Enclosure	FHE
Ground Run-up Enclosure	GRE
IT Hut (North)	HUT
Employee Lot (Alderwood)	LAR
Economy Lot (Red & Blue)	LEA
Ground Transportation Lot	LGT
Employee Lot (HQ)	LHQ
Long Term Lot	LLT
Maintenance Annex	MXA
Maintenance	MXF
North Cargo	NCR
Passenger Boarding Bridge Concourse B	PBB
Passenger Boarding Bridge Concourse C	PBC
Passenger Boarding Bridge Concourse D	PBD
Passenger Boarding Bridge Concourse E	PBE
P1 - Parking Garage	PGA
P2 - Parking Garage	PGB
HQ Headquarters	POP
Quick Turn Around (Car Wash)	QTA
DMS Reader Airport Way	RAW
DMS Reader 82nd Ave	RND
South Cargo	SCR
South IT Hut	SIH
Sewage Pump Station	SPS
Taxi Hold Area	TAX
Tower	TOW
Toll Plaza	TPL

Site Name	Abbreviation
Main Terminal Bldg	TRM

3.4 TELECOM SPACE IDENTIFIERS

A. PDX

Site Name	Floor No.	Room No. *	Telecom Space Identifier *
TRM	1	*T1xxx*	*1X*
	2	*T2xxx*	*2X*
	3	*T3xxx*	*2X*
CCA	1	*A1xxx*	*1X*
	2	*A2xxx*	*2X*
CCB	1	*B1xxx*	*1X*
CCC	Tunnel	*C-0x*	*0X*
	1	*C1xxx*	*1X*
	2	*C2xxx*	*2X*
	3	*C3xxx*	*3X*
CCD	Tunnel	*D-0x*	*0X*
	1	*D1xxx*	*1X*
	2	*D2xxx*	*2X*
	3	*D3xxx*	*3X*
CCE	Tunnel	*E-0x*	*0X*
	1	*E1xxx*	*1X*
	3	*E3xxx*	*3X*
PGA	Tunnel	*P0xxx*	*0X*
	8	*P8xxx*	*8X*
CUP	-	*Room Name*	*1X*
MXF	1	*M1xx*	*1X*
	2	*M2xx*	*2X*
DPS	-	*PS-X*	*1X*
LLT	-	*Room Name*	*1X*
CPS	-	*Room Name*	*1X*
TPL	-	*Room Name*	*1X*

* There are multiple room numbers with associated telecom space identifiers not shown for security reasons. Information will be provided as required for specific construction activity.

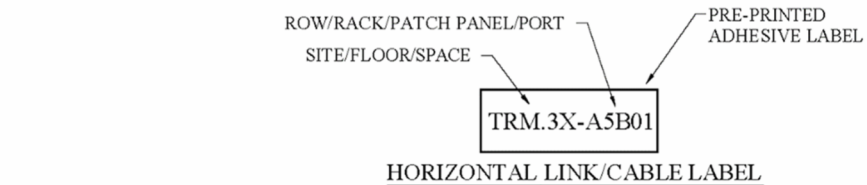
3.5 OPTIONAL IDENTIFIERS

A. Use the following where required on riser/backbone labels.

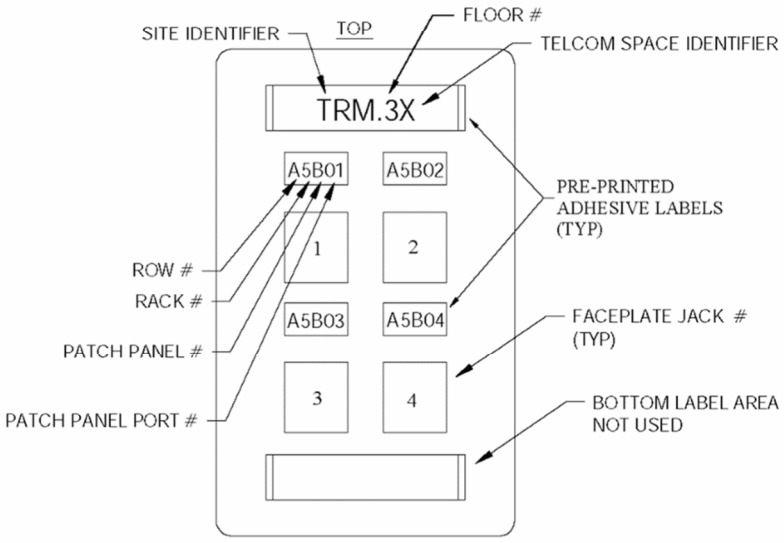
C Copper

F	Fiber
X	Coax
W	Wireless
M	Multimode
S	Single Mode
Z	Splice Case

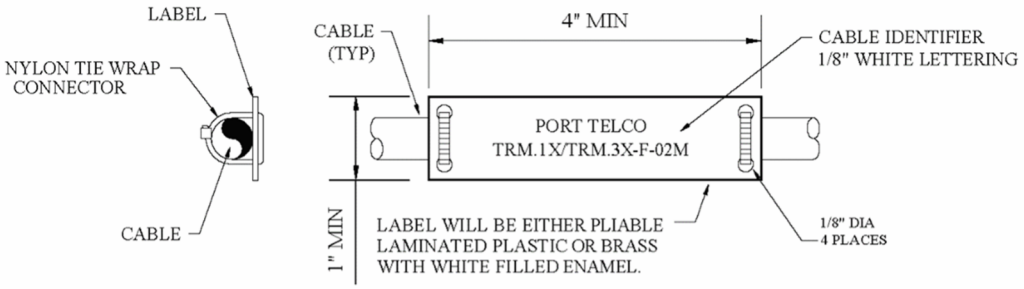
PORT STANDARDS FOR TELECOMMUNICATION LABELING



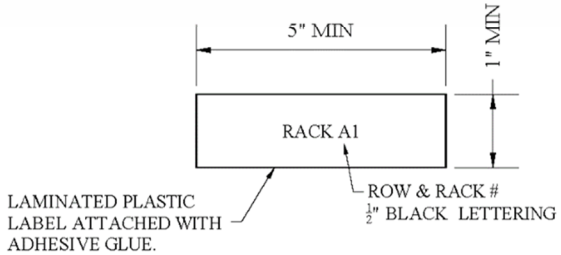
HORIZONTAL LINK/CABLE LABEL
SCALE: N.T.S.



TELECOMMUNICATION OUTLET FACE PLATE
SCALE: N.T.S.

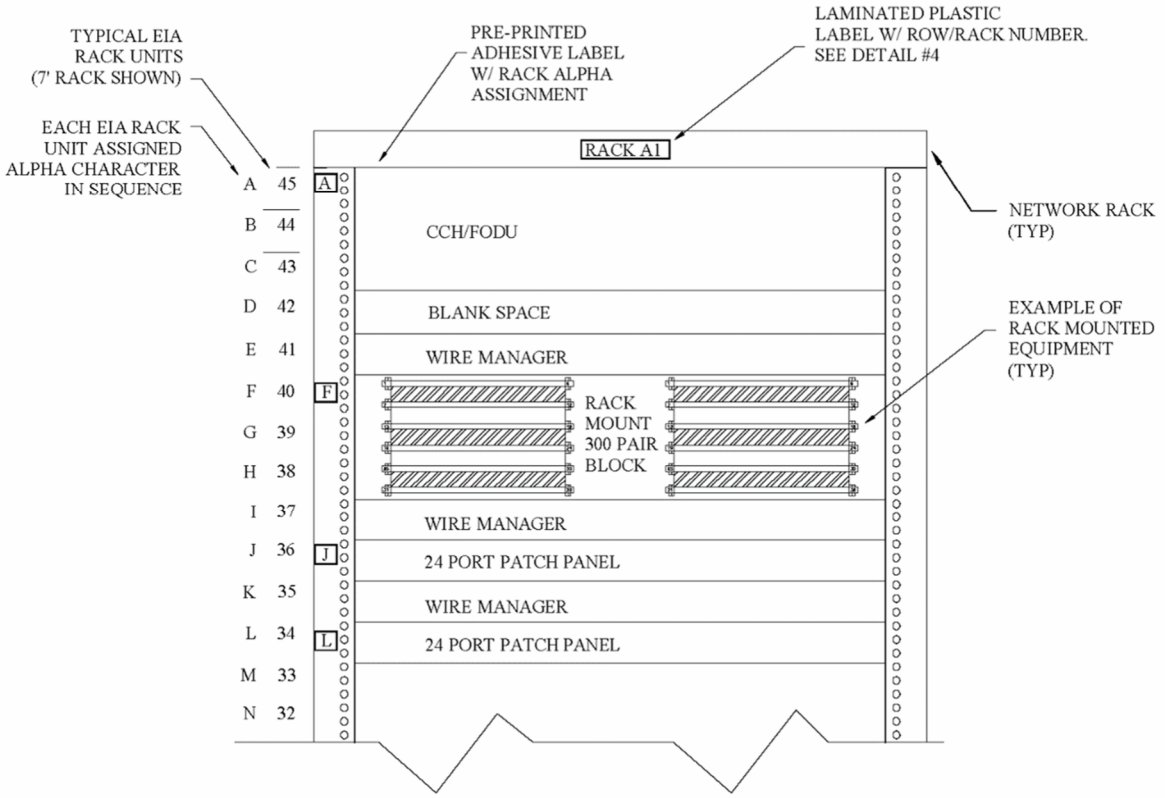


RISER/BACKBONE CABLE IDENTIFICATION
SCALE: N.T.S.

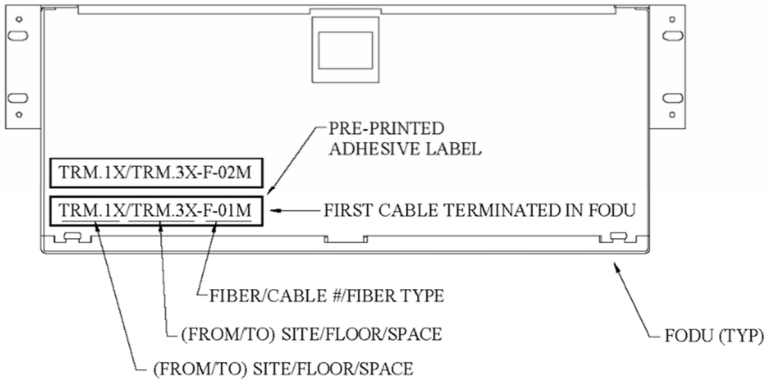


NETWORK RACK IDENTIFICATION
SCALE: N.T.S.

PORT STANDARDS FOR TELECOMMUNICATION LABELING



RACK IDENTIFICATION
SCALE: N.T.S.



FODU IDENTIFICATION
SCALE: N.T.S.

END OF SECTION 27 05 53

SECTION 27 10 00 – STRUCTURED CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. This section describes copper and fiber infrastructure for the communication and data network system.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 26 05 26, Grounding and Bonding for Electrical Systems

B. Section 26 05 33, Raceway and Boxes for Electrical Systems

C. Section 27 05 53, Identification for Telecommunication Systems

D. Section 28 10 00, Security Access Control System

E. Section 28 20 00, Video Surveillance

1.4 REFERENCES

A. Install equipment and materials in accordance with the applicable standards of the following organizations:
   1. ANSI: American National Standards Institute
   2. ANSI/TIA: American National Standards Institute and Telecommunications Industry Association
      a. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
      b. ANSI/TIA-568-C.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standard
      c. ANSI/TIA-568-C.3: Optical Fiber Cabling Components
      d. ANSI/TIA-607-C: Generic Telecommunications Bonding and Grounding for Customer Premises
   3. BICSI: Building Industry Consulting Service International
   4. EIA: Electronic Industries Alliance
      a. EIA-310: Cabinets, Racks, Panels, and Associated Equipment
   5. IBC: International Building Code
   6. IFC: International Fire Code
   7. NEC: National Electrical Code
   8. NEMA: National Electrical Manufacturers Association

9. UL: Underwriters Laboratories

1.5 SUBMITTALS

A. Submit product data for the following:
   1. Cable
   2. Connectors
   3. Cable management
   4. Patch panels
   5. Termination blocks
   6. Closet connector housing (CCH)/Fiber optic distribution unit (FODU)
   7. Modular patch cords
   8. Faceplates
   9. Jacks
   10. Modular plugs
   11. Equipment racks
   12. Power strips
   13. Surge protectors

B. Submit the quantity and lengths of modular patch cords to be provided by the Contractor in accordance with project requirements.

C. Shop Drawings: Prepare and submit coordination drawings detailing raceways and system components and materials in relation to other building systems and components. Drawings shall include, but not be limited to, the following:
   1. Floor plans detailing raceway and cabling installations.
   2. Enlarged network and equipment room plans showing room layouts including coordination drawings detailing all equipment to be installed by other trades within the enlarged area.
   3. Wall-mounted facilities on terminal backboards.
   4. Equipment rack and cabinet elevations for all termination locations.
   5. Detail drawings shall include clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
   6. Cable and equipment labeling schemes and sample labels as coordinated with the Port and in accordance Section 270553.
   7. See the drawings for completed telecommunications, backbone cabling, and horizontal cable matrix schedules. Complete these schedules upon field verification of installation locations of patch panels, racks, cabinets, etc., and submit to the Port for approval prior to commencement of work.

D. Submit Contractor qualifications, upon request, including:
   1. Contractor's current certification for the manufacturer's certified installer program.
   2. Manufacturer's Category 6A certifications for each technician performing installation on the project.
   3. Manufacturer's certificate of completion on the following course for each technician performing installation on the project:
      a. Atlas-X1 Shielded Installation Training provided by Leviton Network Solutions.

4. Manufacturer's fiber optic cable and connector certifications for each technician performing installation on the project.

E. Submit certified equipment calibration records performed by the equipment manufacturer stating that the equipment that will be used in the testing of copper and fiber optic cables installed as part of the work was calibrated within the past 6 months.

F. Product Data Manuals: Upon completion of the project, submit final product data manuals that include:
1. A complete as-installed equipment list of all components installed with manufacturers' names and model numbers.
2. A complete set of product data sheets for all products installed. Product data sheets shall be clearly marked, identifying the specific items installed.

G. Review of product data does not relieve the Contractor from responsibility for deviations from the drawings or specifications, unless the Contractor has, in writing, called attention to such deviations at the time of submission and obtained written approval from the Port.

H. As-Constructed Documents: Maintain real-time as-constructed documentation for the installed structured cabling system.
1. Update and revise contract documents to record actual locations (as-installed) of all equipment, pull boxes, devices, raceways, cabling, outlets, and cable infrastructure components.
2. As-constructed drawings shall include:
   a. Complete site plans, floor plans, and enlarged plans and site plans indicating placement and routing of as-installed raceways, junction boxes, racks, cabinets, cables, and communications outlet locations and types with labels and cabling facilities installed. Cabling shall include callouts detailing Port cable designation.
   b. Complete structured cabling riser diagrams showing as-installed originations, destinations, and type of pathways for all cabling. Include cabling numbers, terminal block numbers and layouts, and other designations.
   c. Equipment rack/cabinet and wallboard elevation drawings for each network room and cable termination location.
   d. Final, as-terminated fiber optic distribution unit (FODU) schedules and details.

I. Test Reports: The Contractor shall be responsible for recording all test data. Submit copies of all test results to the Port for review and approval no later than one week after completion of the testing.
1. Prior to commencement of cable testing, submit a sample test report, with the assigned cable designation clearly indicated, of each test type to the Port for approval.
2. Submit final test report schedules which confirm that the cabling infrastructure has been tested, labeled, and documented.
3. Submit the test reports and schedules with the testing software program on CD-ROM or DVD.

J. Submit operation and maintenance manuals. Content of each manual or chapter shall include, but not be limited to, the following:
1. Description of system.

2. Manufacturers' brochures. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists. Edit the manufacturers' standard brochures so that the information applying to the actual installed equipment is clearly defined.

K. Submit manufacturers' equipment guarantees or warranties for applicable systems and components.

1.6 QUALITY ASSURANCE

A. The work shall be performed by Oregon Limited Energy Journeyman licensed technician(s).

B. The structured cabling system shall be installed by a value-added reseller for the manufacturers specified and their respective products. Each of the Contractor's installing technicians shall have completed the manufacturer's training for the installation of shielded cabling systems (Atlas-X1 Shielded Installation Training) and be a certified member in good standing of the manufacturer installer program before, during, and through completion of the system installation.

1.7 WARRANTY

A. Provide the following:
1. Limited Lifetime Berk-Tek/Leviton materials warranty on parts and labor to repair/replace defective telecommunications copper station cabling materials and associated products.
2. Minimum 25-year Corning Cable Systems warranty on parts and labor to repair/replace defective telecommunications fiber backbone and fiber station cabling materials and associated products.

B. Passive components and products (cables, connectors, patch panels, and/or other associated components) shall come from the manufacturers listed above to offer an extended warranty on the structured cabling system being installed. The Contractor or the Contractor's installer shall be certified by Berk-Tek/Leviton or Corning to provide the materials warranty and shall meet all necessary requirements to make the Port eligible for the extended warranties. Upon completion, submit a certificate from the sponsoring manufacturer stating that the installed system is covered by the manufacturer's extended warranty for the minimum period applicable.

C. The Port shall be named the owner of the warranty and guaranteed full and complete rights under the warranty.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Communications products installed as part of this work shall be listed by a recognized testing laboratory or approved in writing by the inspection authority as required by governing codes and ordinances.

B. Materials shall be new and of the best quality. The materials shall be manufactured in accordance with NEMA, ANSI, UL, or other applicable standards.

C. Equipment and materials of the same general type shall be of the same manufacturer throughout the work to provide uniform appearance, operation, and maintenance.

D. Cable jacket shall be plenum-rated and marked with the CMP designation where appropriate and as required by code for installation in plenum-rated areas.

E. The structured cabling system components for the horizontal cabling shall consist entirely of products from CS6700 CAT6A Shielded System by Berk-Tek/Leviton, or pre-bid approved equal.

2.2 FIBER OPTIC CABLE

A. Fiber optic cables shall be single-mode, loose tube, riser/plenum rated for the environment of the installation. Corning FREEDM Cable Series, or pre-bid approved equal.
   1. Singlemode fiber shall be 8.3um/125um.
   2. Where installed in cable tray, cable shall be armored.

B. Cable strand size as indicated on the drawings.

2.3 SHIELD BOND CONNECTORS

A. 3M Scotchlok Bonding Connectors, 3M Part No. Series 4460, or pre-bid approved equal, shall be used to bond multi-pair copper cable jackets to appropriate ground at building entrance terminal locations.

2.4 HORIZONTAL CABLE - EXTERIOR

A. Horizontal cables shall be four-pair, unshielded, twisted pair (UTP), #23 AWG solid copper conductors, paired, polyethylene insulated.

B. Manufacturer: Berk-Tek LANmark-10G CAT6A OSP cable (Part No. 11094458), or pre-bid approved equal.

C. Cable fill shall contain a water-resistant flooding compound.

D. Cable jacket shall be black in color.

2.5 CABLE MANAGEMENT COMPONENTS

A. Vertical Cable Management: Chatsworth Evolution G3 combination vertical cable manager or pre-bid approved equal, clear in color, sized as indicated below:
   1. In existing network rooms: 6" W x 20.2" D x 7' H, Part No. TS1037525.
   2. In new network rooms: 8" W x 20.2" D x 7' H, Part No. TS1037513.

B. Horizontal Cable Management:
   1. Rack Mount FODUs:
      a. 1RU: 19-inch horizontal cable manager. CPI Evolution G3 1RU (Part No. 35441-701), or pre-bid approved equal.
      b. 2RU: 19-inch horizontal cable manager. CPI Evolution G3 2RU (Part No. 35441-702), or pre-bid approved equal.
   2. Wall Mount R66 and 110 Termination Blocks: Siemon S110A2RMS, or pre-bid approved equal.

C. Filler Patch Panels:
   1. Top Patch Panel in a Rack: 1RU blank angled plate with transitional cover. Leviton 49254-BC1, or pre-bid approved equal.
   2. Subsequent Patch Panels in a Rack: 1RU blank angled plate. Leviton 49254-BA1, or pre-bid approved equal.

2.6 HORIZONTAL CABLE PATCH PANELS

A. Design patch panels for installation on standard NEMA 19-inch equipment racks.

B. Patch panels shall be certified by the manufacturer to ensure optimal channel performance of the structured cable system. Leviton Atlas-X1 Angled Shielded QuickPort 24 Port Patch Panel+ (Part No. 4S256-S24), or pre-bid approved equal.

2.7 BACKBONE CABLE TERMINATION BLOCKS

A. Wall Mount 110 Termination Block:
   1. Provide termination blocks with legs for installation on 3/4-inch plywood backboards.
   2. Termination blocks shall be 110 termination with tin lead-plated insulation displacement connector (IDC). Siemon S110 wiring blocks or S110 field terminated block kit, Part No. S110A52-100FT/300FT, or pre-bid approved equal, quantity and size as indicated on the drawings.

B. Rack Mount Termination Block:
   1. Design termination blocks for installation on standard NEMA 19-inch equipment racks.
   2. Termination blocks shall be 110 termination with tin lead-plated insulation displacement connector (IDC). Siemon field terminated panels with cable managers, Part No. S110D52-200RWM, or pre-bid approved equal, quantity as indicated on the drawings.

2.8 FIBER CONNECTORS

A. In Existing FODUs with Fan-Out Kits:
   1. Terminate singlemode fiber ends with LC ceramic ferrule connectors. Corning FuseLite splice on connector, or pre-bid approved equal.
   2. Bare fibers shall be protected using buffer tube fan-out kits prior to termination. Corning Cable Systems Part No. FAN-BT25-1, or pre-bid approved equal.

B. Wall Mount FODUs:
   1. Terminate singlemode fiber ends with LC ceramic ferrule connectors. Corning FuseLite splice on connector, Part No. SOC-LCU-900-SM, or pre-bid approved equal.

C. New 2 or 4 RU FODUs:
   1. Rack mountable CCH splice cassette loaded with LC connectors, CCH panel and factory-terminated pigtails. Corning Cabling Systems, Part Nos. CCH-CS12-A9-P00RE and CCH-CS24-A9-P00RE, or pre-bid approved equal.

2.9 CLOSET CONNECTOR HOUSING (CCH)/FIBER OPTIC DISTRIBUTION UNIT (FODU)

A. Network, Equipment Rooms:
   1. CCH with LC bulkheads, connector panels, and associated hardware.
   2. Closet connector housings shall be black in color.
   3. CCH housing size as indicated on the drawings.

B. Wall Mount FODUs:
   1. Surface mountable CCH with LC bulkheads, connector panels, splice trays, and associated hardware. Corning Cabling Systems, Part No. ICH-02P, or pre-bid approved equal.
   2. Closet connector housings shall be black in color.
   3. CCH housing size as indicated on the drawings.

2.10 CATEGORY 6A MODULAR PATCH CORDS

A. Provide Leviton CAT6A high-flex copper patch cords, Part No. H6A10-xxS, or pre-bid approved equal.
   1. For field devices installed such as, but not limited to, interface terminal box (ITB) edge controllers, video surveillance cameras, flight information displays, gate operators, and biometric readers.
      a. Provide one patch cord (installed by the Contractor) at the device end, length as required.
   2. For the total number of horizontal cables installed (including for field devices):
      a. Provide one patch cord, 7 feet in length, for 60 percent of total horizontal cables installed.
      b. Provide one patch cord, 10 feet in length, for 60 percent of total horizontal cables installed.

B. Modular patch cords shall be certified by the manufacturer to ensure optimum channel performance for the structured cabling system. Leviton, or pre-bid approved equal.

C. Modular patch cords shall be grey in color.

2.11 JACKS

A. Shielded jacks shall be purple, Leviton Atlas-X1 CAT6A Shielded QuickPort Connector Part No. 6ASJK-RP6, or pre-bid approved equal.

B. Unshielded jacks shall be purple, Leviton Atlas-X1 CAT6A UTP QuickPort Connector Part No. 6AUJK-RP6, or pre-bid approved equal.

C. Wall mount jacks (for wall phones) shall be stainless steel Leviton Recessed Wallplate Part No. 4108W-1SP, or pre-bid approved equal.

2.12 MODULUAR PLUGS

A. Modular plugs shall be shielded CAT6A, tool-free, Part No. Leviton CAT6APLG-S6A, or pre-bid approved equal.

2.13 CABLE PROTECTION COMPONENTS

A. Spiral cable wrap, flame retardant polyethylene (UL94V-0), 0.25 OD, wraps cable bundles from 3/16 inch to 2 inch, color shall be black. Panduit Part No. T25FR-C, or pre-bid approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide services, labor, material, and components necessary for a complete and finished installation.

B. Install equipment, patch panels, and termination blocks between 1 foot 6 inches AFF and 6 feet 6 inches AFF on equipment racks or backboards as appropriate.

C. Install firestops and seals at penetrations through building floors, walls, or where required by fire codes.

D. Field test cables prior to installation. Replace damaged cables.

E. Inspect cable for sheath defects or other irregularities as it is pulled out. Upon detection of defects, stop pulling and repair or replace the cable section.

F. Install cables continuously with no splices.

G. Provide bonding for all equipment within telecom rooms in accordance with manufacturer's requirements.

H. Provide rack anchor bolts and attachments, installation of cable runway, and anchoring of equipment in accordance with the manufacturer's recommendations. Provide engineered/stamped seismic calculation where required by code.

I. Provide vertical and horizontal cable management troughs as appropriate for the installation and as indicated on the drawings.

3.2 GROUNDING

A. Comply with grounding specifications of EIA/TIA-607-C: Generic Telecommunications Bonding and Grounding for Customer Premises.

3.3 EQUIPMENT SUPPORT

A. Each fastening device and support for communications equipment and racks shall be capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure and shall be installed to resist seismic forces as specified in the IBC for the ground motion accelerations corresponding to the project location.

B. Powder-actuated or similar shot-in fastening devices will not be permitted for any communications work except when approved by the Port.

3.4 ALIGNMENT

A. Install racks and equipment level and plumb, parallel with structural building lines. Communications enclosures shall fit neatly without gaps, openings, or distortion. Properly and neatly close unused openings with approved devices.

B. Fit outlets with neat, appropriate trims, plates, or covers, without overhanging edges, protruding corners, or raw edges, to leave a finished appearance.

3.5 CUTTING AND PATCHING

A. Include cutting, patching, and restoration of finishes. Surfaces damaged by this work shall be neatly patched and finished to match the adjacent construction, including paint or other finishes. Clean up and remove dirt and debris.

B. Where equipment installations or connections require the installation of an access panel, provide a properly sized and installed access panel similar to those used for mechanical equipment access.

C. Conduit fill shall not exceed NEC fill requirements.

3.6 PROTECTION OF WORK

A. Protect communications work and equipment installed against damage by other trades, weather conditions, or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

B. Communications equipment shall be kept covered or closed to exclude dust, dirt and splashes of plaster, cement, or paint, and shall be free of all such contamination on exterior and interior before acceptance. Enclosures and trims shall be in new condition, free of rust, scratches, and other finish defects. Properly refinish to new condition if damaged.

3.7 MAINTENANCE OF SERVICE

A. Communication systems and equipment shall be maintained to functioning portions of the building throughout construction, during normal working hours of the building occupants. Outages to occupied areas shall be kept to a minimum and require pre-approval from the Port. The Contractor will be liable for any damages resulting from unscheduled outages or for outages not confined to the prearranged times.

3.8 FIBER OPTIC CABLE

A. Install fiber optic cable in inner duct, either existing corrugated or new flexible fabric, when using underground conduits. Use no inner duct in cable trays if armored fiber cable is used. Stop inner duct before entering a network room or computer room. Leave 10 feet of maintenance loop at both ends. Coordinate with the Port for location.

B. For installation of fiber optic cabling in the outside plant raceway system, provide a 15 maintenance loop in every third manhole, vault, or pull box in addition to the maintenance loop indicated above.

C. Fan-Out of Fiber Optic Cable: Prior to termination, fiber optic cable strands shall be furcated (fanned out) using the specified buffer tube fan-out kits and using the procedure specified by the manufacturer.

3.9 TERMINATIONS

A. Terminate horizontal cables on modular jacks inserted in patch panels, faceplates, or surface mount boxes.

B. Terminate backbone cables on 110 field termination blocks as specified and as shown on the drawings. Wrap each binder group with the appropriate color to indicate proper binder group identity. When installing in center hung cable tray, install on the higher side of the tray to keep the cable tray balanced.

C. All four pairs of each horizontal cable shall be terminated in T568B pinout standard order on the jack.

D. Lay out cables on the patch panel as indicated on the cable matrix drawings.

E. Terminate fiber optic cables in FODUs as indicated on the drawings.

3.10 TESTING

A. Upon completion, test systems to show that equipment installed operates as designed and specified. Submit testing plans for review prior to testing. Plan system tests for as many at one time as possible to work into construction phasing. The Port may witness tests at its option and if so, schedule tests 48 hours in advance.

B. A written record of performance tests shall be compiled, dated, witnessed, and submitted along with operating and maintenance data, prior to substantial completion.

C. Test reports shall certify that wiring is complete, passes all test criteria, is fully operational, and that the work has been completed as specified.

D. Provide all forms, instrumentation and test equipment, loads, and other consumables required.

E. Copper CAT6A Horizontal Cable Testing:
   1. Test after jacks are inserted and faceplates correctly mounted and labeled.
   2. Following the final inspection tests and certification by the Contractor, post-certification may be performed through an independent field verification program or testing service. The Port, at its discretion, may require the Contractor to return to the site, at no additional cost to the Port, to assist with the determination of any certification discrepancies. If such a determination finds the materials, installation procedures, or final testing procedures to be out of compliance with this contract, the Contractor shall remedy the cause and re-test, at no additional cost to the Port.
   3. Test copper cables with test equipment designed to substantiate compliance with ANSI/TIA568-C.2. If the test equipment permits, program into the tester "Port of Portland" as the name of "Owner" and the correct cable number under "Circuit ID" appearing on each cable report page. Retain test results and submit.
   4. Perform channel tests on horizontal cables and provide test results on the following electrical signal characteristics:
      a. Wire Map
      b. Length
      c. Resistance
      d. Propagation Delay
      e. Delay Skew
      f. Insertion Loss
      g. Return Loss
      h. Near-End Crosstalk (NEXT)
      i. Power Sum Near-end Crosstalk (PSNEXT)
      j. Attenuation to Crosstalk Ratio Near-End (ACRN)
      k. Power Sum Attenuation to Crosstalk Ratio Near-End (PSACRN)
      l. Attenuation to Crosstalk Ratio Far-End (ACRF)
      m. Power Sum Attenuation to Crosstalk Ratio Far-End (PSACRF)
   5. Test cables to meet ANSI/TIA-568-C.2 standards on the permanent link, equipment outlet to patch panel. The cable installation and products will be deemed acceptable if the Contractor provides documentation substantiating compliance with the electrical signal characteristics of the ANSI/TIA-568-C.2 specifications for horizontal cables.
   6. Approved CAT6A tester is Fluke Versiv with DSX5000 module, or equal.
   7. Correct or replace copper cables and related hardware that fail the acceptance test. Re-test, as outlined in the testing procedures, cables requiring corrective action to meet compliance.
   8. Submit cable test equipment reports on a compact disc using the latest version of the test equipment manufacturer's software, as well as a printed paper copy, for approval. Provide a copy of the test equipment manufacturer's most current release of the test equipment software to allow reading of the test data.

F. Riser and Backbone/OSP Copper Cable Acceptance Testing:
1. Perform testing of copper cabling prior to system use. Test 100 percent of the cable pairs.
2. Test 100 percent of the wiring pairs and cross-connections for opens, shorts, polarity reversals, transposition, and presence of AC voltage.
3. Individually test 100 percent of the cable pairs for continuity, power faults, polarity reversals, transposition, and ground faults. Correct all shorts, opens, crosses, bad termination, foreign voltages, grounding problems, sheath continuity problems, etc.
4. Notify the Port at least 24 hours prior to testing to allow observation. If the Port confirms its intention to observe, a reasonable starting time shall be agreed upon.
5. Record and submit all test results to the Port for verification. Record test results using the forms provided at the end of this section.
6. Following the final inspection tests and certification by the Contractor, post-certification may be performed through an independent field verification program or testing service. The Port, at its discretion, may require the Contractor to return to the site, at no additional cost to the Port, to assist with the determination of any certification discrepancies. If such a determination finds the materials, installation procedures, or final testing procedures to be out of compliance with the contract documents, the Contractor shall remedy the cause and re-test, at no additional cost to the Port.
7. Correct or replace copper cables and related hardware that fail the acceptance test. Re-test, as outlined in the testing procedures, cables requiring corrective action to meet compliance.

G. Fiber Optic Cable Testing:
1. Tier 1 Testing:
   a. Test all fiber strands via the one-jumper reference method.
   b. Fiber test reference cords shall meet ISO/IEC 14763-3 maximum dB loss limits with verifiable maximum loss limits of no more than 0.20dB.
   c. Fiber test reference cords shall be between 2m and 5m in length.
   d. Perform end-to-end, one-directional attenuation test for each fiber strand (connector-to-connector) at 1310 and 1550 wavelengths.
   e. Approved Tier 1 tester is Fluke Versiv with CertiFiber Pro OLTS module, or equal.
2. Tier 2 Testing:
   a. Install a launch cable between the OTDR and the first link connection.
   b. Install a tail cable after the last link connection.
   c. The launch and tail cables shall remain in place for the measurement in the opposite direction.
   d. Launch and tail cable connectors shall not have more than 0.20dB maximum loss.
   e. Launch and tail cables shall have a minimum length of 130m.
   f. Perform end-to-end, bi-directional attenuation test for each fiber strand (connector-to-connector) at 1310 and 1550 wavelengths.
   g. Approved Tier 2 tester is Fluke Versiv with OptiFiber Pro OTDR module, or equal.
3. Fluke field-test instrument shall be within the calibration period recommended by the manufacturer and a copy of the calibration certificate shall be made available.
4. Calculate the fiber optic attenuation loss budget using the manufacturer's specified attenuation per linear foot of fiber. Calculate singlemode connectors using the manufacturer's published values of 0.30 dB per connector for the maximum loss.
5. No singlemode mated pair connector will be accepted if field test result loss is greater than 0.50 dB.
6. Place terminated fiber connectors in duplex fiber bulkheads and panels sequentially per the fiber color code. Polarity shall be straight through.

7. Submit a copy of the OLTS and OTDR test reports on a compact disc using the latest version of the test equipment manufacturer's software, as well as a printed paper copy, for approval. Include a copy of the test equipment manufacturer's most current release of the test equipment software.
8. Following the final inspection tests and certification by the Contractor, post-certification may be performed through an independent field verification program or testing service. The Port, at its discretion, may require the Contractor to return to the site, at no additional cost to the Port, to assist with the determination of any certification discrepancies. If such a determination finds the materials, installation procedures, or final testing procedures to be out of compliance with the contract documents, the Contractor shall remedy the cause and re-test, at no additional cost to the Port.
9. Fiber strands not in compliance with manufacturer's performance specifications shall be removed, replaced, and re-tested as outlined in the testing procedures.

BACKBONE COPPER CABLE TEST RESULTS					
CONTRACTOR:					DATE:
PROJECT:					
TEST EQUIPMENT:					
CABLE LABEL:					
CABLE COUNT:					
PAIR	CONTINUITY	OPEN	SHORT	CROSSED	COMMENTS
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

BACKBONE COPPER CABLE TEST RESULTS							
CONTRACTOR:					DATE:		
TEST EQUIPMENT							
PROJECT:							
			MEASURED			CALCULATED	
TEST LOCATION NAME	CABLE COUNT/CABLE NAME	BAD PAIRS	COPPER CABLE CUMULATIVE FOOTAGE	LOOP RESISTANCE MEASURED IN OHMS	dB LOSS @ 1Khz	dB LOSS @ 1Khz	dB LOSS @ 1Khz

END OF SECTION 27 10 00

SECTION 28 10 00 - ACCESS CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Access control system.

B. Related Requirements:

1. Section 28 13 00 "Access Control Software and Database Management" specifies the following:

a. Access control system unit operating system software.
b. Access control system unit antivirus and security protection software.
c. Visitor management database software.
d. Mobile credential validation database software.
e. Access control system supplementary computer equipment operating system software.
f. Access control system supplementary computer equipment antivirus and security protection software.
g. Credential card personalization software.
h. Credential card printer and encoder software.

1.3 DEFINITIONS

A. DGP: Data gathering panel.

B. NFC: Near field communications.

C. REX: Request-to-exit.

1.4 ACTION SUBMITTALS

A. Shop Drawings:

1. Project general notes.
2. Head-end hardware, equipment, and device locations.
3. Block diagram and cable/conduit routing illustrating end-to-end system wiring.

4. End-to-end system communications details.
5. Secondary power calculations

B. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.6 CLOSEOUT SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Installation and programming instructions for operating system software, including all applicable software add-ons.
2. Installation and programming instructions for antivirus and security protection software.
3. Manufacturer's recommended setup and testing procedure for operating system software and applicable software add-ons.
4. Troubleshooting instructions for operating system software and applicable software add-ons.
5. Manufacturer's recommended setup and testing procedure for antivirus and security protection software.
6. Troubleshooting instructions for antivirus and security protection software.
7. Installation instructions for access control system servers.
8. Installation instructions for access control system input/output interface.
9. Installation instructions for access control system door controllers.
10. Installation instructions for access control system workstation.
11. Installation instructions for access control system power supplies and battery chargers.
12. Installation instructions for access control system printers.
13. Manufacturer's recommended testing and inspection procedure for operation of access control system servers, panels, input/output interfaces, door controllers, and workstations.
14. Manufacturer's recommended testing and inspection procedure for operation of access control system power supplies and battery chargers.
15. Manufacturer's recommended testing and inspection procedure for operation of access control system printers.
16. Installation instructions for integrated credential readers and entry management devices.
17. Printing, programming, and handling instructions for access control credentials.
18. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
19. Manufacturer's recommended testing and inspection procedure for end-to-end operation of access control system software, hardware, and integrated hardware devices.

B. Warranty documentation.

1.7 REGULATORY AGENCY APPROVALS

A. Submittals for access control system requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation.

B. Submittals for access control system require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.8 WARRANTY AND SERVICE LEVEL AGREEMENT

A. Manufacturer Warranty: Provide proof of manufacturer provided warranties including beginning of warranty period, duration of warranty, expiration of warranty, coverage clause and exceptions, repair, and replacement procedures.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of provided equipment that fail in materials or workmanship within specified warranty period.

C. Workmanship Warranty: Provide a workmanship warranty for a period of 1-year from date of system acceptance. Workmanship warranty shall cover 100 percent of the costs of labor and materials to diagnose, repair and/or replace equipment that fails or is not functioning per the equipment specifications.
   1. Warranty service requests should be responded to within the timeframe specified in the on-call general service request.

D. Service Level Agreement: Provide for a period of 1-year from date of system acceptance service level agreements that includes the following services:
   1. Semi-Annual firmware updates for all provided device. Provide a report specifying the firmware prior to and after the firmware updates and changes to the firmware with the update and any device failures.
   2. Conduct annual security systemwide testing and cleaning to include:
      a. Inspecting and cleaning the exterior housing for all cameras and readers.
      b. Validate, valid entry, valid exit, door held, and door forced alarms are properly triggering and alarming for each access point.
      c. Validate all monitored alarms are properly triggering, displayed within the access control system, and at control room, and the proper local alarms are triggering as designed.
      d. Validate all cameras are recording per the system specifications.
      e. Provide screen shots of each camera view during daylight and nighttime hours.
      f. Review of system alarms and summary of concerns or issues related to the alarms and recommended remedies.
      g. Report of all tests performed, test results, and device settings.
      h. Executive summary of general system health review findings, recommendations for improvements to be made and associated cost estimates.

   3. On-call services to include:
      a. 24/7 emergency technical support hotline
      b. Emergency technical support dispatch with guaranteed response within one (1) hour and onsite service technician within eight (8) hours of call.

c. General service request for services to be responded to within one (2) business days of service request and onsite service technician within ten (10) business days or request.

4. Provide quotations for additional 3- and 5- year service level agreements.

PART 2 - PRODUCTS

2.1 MANUFACTUERERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 ACCESS CONTROL SOFTWARE AND DATABASE MANAGEMENT

A. Description: This category covers software products intended for installation on access control system units.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria:

a. Cybersecurity: UL CCN CYBR; including UL 2900-1 and UL 2900-2-3.
b. Access Control System Functionality: UL CCN ALVY; including UL 294.
c. Hardware that Interfaces with Fire Alarm or Mass Notification: UL CCN UOJK; including UL 864.

C. Access Control System Unit Operating System Software:

1. Manufacturers:

The access control software must incorporate an API integration with the video surveillance system. The following are acceptable pairings manufacturers:

a. AMAG
   1) Symmetry Access Control

2. Additional Characteristics:

a. Provides event logging, notification, and escalation.
b. Provides threat-level management and response actions.

c. Provides dashboard view of system health and status.
d. Maintains credential-driven user records and access history.
e. Supports network-connected credential readers and controlled doors.
f. Supports add-on software.
g. Supports video surveillance system integration.

3. Options:

a. Operating System: Windows 11.
b. User Interface: Mobile app.
c. Web Browser: Microsoft Edge and Google Chrome.
d. Drive Space: 500 GB.
e. Memory: 16 GB.
f. Number of Cardholders: Up to 50,000.
g. Number of Supported Readers: Up to 500.
h. Number of Inputs: 1024.
i. Number of Outputs: 1024.
j. Simultaneous Users: 25.

D. Operation:

1. Security access system shall use a single database for access-control and credential-creation functions.
2. Security access system shall be capable of accessing Active Directory for credential-creation and functions.
3. Controller based Processing:

a. Access-control information, including time, date, valid codes, access levels, and similar data, shall be downloaded to controllers so each controller can make access-control decisions.
b. Intermediate controllers for access control are prohibited.
c. In the event that communications with the central controller are lost, controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the access server.

4. Number of Locations:

a. Support at least 255 separate database controllers using a single communications server with combinations dial-up, or TCP/IP LAN connections to each Location.
b. Each controller shall have its own database and history.

5. System Network Requirements:

a. System components shall be interconnected and shall provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
b. Communication shall not require operator initiation or response and shall return to normal after partial- or total-network interruption such as power loss or transient upset.
c. System shall automatically communicate failures to the operator and shall identify the communications link that has experienced a partial or total failure.

6. Central server shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central server shall control system networks to interconnect all system components, including workstations and field-installed controllers.
7. System Response to Alarms:

    a. Alarms shall be communicated at the central server within three second of the alarm occurring at a controller or at a device controlled by a local controller, and within 1 second if the alarm occurs at the central server.
    b. Alarm and status changes shall be displayed within 1 second after receipt of data by the central server.
    c. All graphics shall be displayed, including graphics-generated map displays, on the console monitor within five seconds of alarm receipt at the security console.
    d. This response time shall be maintained during system heavy load.

8. False-Alarm Reduction: The design of the central server and controllers shall contain features to reduce false alarms. Equipment and software shall comply with SIA CP-01.
9. Error Detection:

    a. A message shall be in error if one bit is received incorrectly.
    b. Retransmit messages with detected errors.
    c. Monitor the frequency of data transmission failure for display and logging.

10. Data Line Supervision: System shall initiate an alarm in response to opening, closing, shorting, or grounding of data transmission lines.
11. Door Hardware Interface:

    a. Comply with hardware requirements for door hardware that is required to be monitored or controlled by the security access system.
    b. Electrical characteristics of controllers shall match the signal and power requirements of door hardware.

E. Application Software:

1. System Software: Based on 64-bit server and workstation operating system and application software.

    a. Multiuser multitasking shall allow independent activities and monitoring to occur simultaneously at different workstations.
    b. Capability for future additions within the indicated system size limits.
    c. Open architecture that allows importing and exporting of data and interfacing with other systems that are compatible with operating system.
    d. Password-protected operator login and access.

2. Workstation Software:

    a. User levels shall be individually customized by login credentials to allow or disallow operator access to program functions for each Location.
    b. Workstation event filtering shall allow user to define events and alarms that will be displayed at each workstation. If an alarm is unacknowledged (not handled by another workstation) for a preset amount of time, the alarm will automatically appear on the filtered workstation.

3. Controller Software:

   a. Controllers shall operate as autonomous, intelligent processing units.

      1) Controllers shall make decisions about access control, alarm monitoring, linking functions, and door-locking schedules for their operation, independent of other system components.
      2) Controllers shall be part of a fully distributed processing-control network.
      3) The portion of the database associated with a controller, and consisting of parameters, constraints, and the latest value or status of points connected to that controller, shall be maintained in the controller.

   b. The following functions shall be fully implemented and operational within each controller:

      1) Monitoring inputs.
      2) Controlling outputs.
      3) Automatically reporting alarms to the central server.
      4) Reporting of sensor and output status to the central server on request.
      5) Maintaining real time, automatically updated by the central server at least once a day.
      6) Communicating with the central server.
      7) Diagnosing.
      8) Downloading and uploading data to and from the central server.

   c. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central server at least once a day to ±10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

4. Server-to-Controller Communication:

   a. Central-server or workstation communications shall use the following:

      1) TCP/IP LAN interface cards.
      2) Dial-up for connections to Locations without LAN.

   b. TCP/IP and dial-up shall be alike in the monitoring or control of the system except for the connection that must first be made to a dial-up.
   c. Communication Server-to-controller and controller-to-controller communications (dial-up, or TCP/IP) shall use a polled-communication protocol that checks sum and acknowledges each message. All communications in this subparagraph shall be verified and buffered and retransmitted if not acknowledged.

5. TCP/IP PC-to-Controller Communications:

   a. Communication software on the PC shall supervise the PC-to-controller communications link.
   b. Loss of communications to any controller shall result in an alarm at all PCs running the communication software.

c. When communications are restored, all buffered events shall automatically upload to the PC, and any database changes shall be automatically sent to the controller.

6. Database Downloads:

a. All data transmissions from PCs to a Location, and between controllers at a Location, shall include a complete database checksum to check the integrity of the transmission. If the data checksum does not match, a full data download shall be automatically retransmitted.
b. If a controller is reset for any reason, it shall automatically request and receive a database download from the PC. The download shall restore data stored at the controller to their normal working state and shall take place with no operator intervention.
c. Software shall provide for setting downloads via dial-up connection to once per 24-hour period, with time selected by the operator.
d. Software shall provide for setting delays of database downloads for dial-up connections. Delays change the download from immediately to a delay ranging from one to 999 min.

7. Operator Access Control:

a. Control operator access to system controls through five configurable password-protected operator levels. Master installer level (full rights), Administrator level (complete system usage), Shift Lead level, Operator, and user level. Administrator level should be able to change all access levels for the Shift Lead, operator, and user levels.
b. Three successive attempts by an operator to execute functions beyond their defined level during a 24-hour period shall initiate a software tamper alarm.
c. The password shall not be displayed or printed.
d. Each password shall be definable and assignable for the following:

1) Selected commands to be usable.
2) Access to system software.
3) Access to application software.
4) Individual zones that are to be accessed.
5) Access to database.

8. Alarms:

a. System Setup:

1) Assign manual and automatic responses to incoming-point status change or alarms.
2) Automatically respond to input with a link to other inputs, outputs, or operator-response plans; unique sound files; and maps or images that graphically represent the point location.
3) Minimum of sixty-character message field for each alarm.
4) Operator-response-action messages shall allow message length of at least 65,000 characters, with database storage capacity of up to 32,000 messages.
5) Secondary messages shall be assignable by the operator for printing to provide further information and shall be editable by the operator.

6) Allow 25 secondary messages with a field of four lines of 60 characters each.
7) Store the most recent 1,000 alarms for recall by the operator using the report generator.

b. Software Tamper:

1) Communicate a tamper alarm when unauthorized changes to system database files are attempted. Three consecutive unsuccessful attempts to log onto system shall generate a software tamper alarm.
2) Communicate a software tamper alarm when an operator or other individual makes three consecutive unsuccessful attempts to invoke functions beyond the authorization level.
3) Maintain a transcript file of the last 5,000 commands entered at each central server to serve as an audit trail. System shall not allow write access to system transcript files by any person, regardless of their authorization level.
4) Allow only acknowledgment of software tamper alarms.

c. Read access to system transcript files shall be reserved for operators with the highest password authorization level available in system.
d. Animated Response Graphics: Highlight alarms with flashing icons on graphic maps; display and constantly update the current status of alarm inputs and outputs in real time through animated icons.
e. Multimedia Alarm Annunciation: Audio files to be associated with alarm events for audio annunciation or instructions.
f. Alarm Handling: Each input may be configured so that an alarm cannot be cleared unless it has returned to normal, with options of requiring the operator to enter a comment about disposition of alarm. Allow operator to silence alarm sound when alarm is acknowledged.
g. Alarm Automation Interface: High-level interface to central-station alarm automation software systems. Allows input alarms to be passed to and handled by automation systems in the same manner as burglar alarms.
h. Video Surveillance Alarm Interface: Allow commands to be sent to video surveillance systems during alarms (or input change of state).
i. Camera Control: Provides operator ability to select and control cameras from graphic maps.

9. Alarm Monitoring: Monitor sensors, controllers, and notify operators of an alarm condition. Display higher-priority alarms first and, within alarm priorities, display the oldest unacknowledged alarm first. Operator acknowledgment of one alarm shall not be considered acknowledgment of other alarms nor shall it inhibit reporting of subsequent alarms.

a. Displayed alarm data shall include type of alarm, location of alarm, and secondary alarm messages.
b. Maps shall automatically display the alarm condition for each input assigned to that map if that option is selected for that input location.
c. Alarms initiate a status of "pending" and require the following two handling steps by operators:

1) First Operator Step: "Acknowledged." This action shall silence sounds associated with the alarm. The alarm remains in the system "Acknowledged" but "Un-Resolved."
2) Second Operator Step: Operators enter the resolution or operator comment, giving the disposition of the alarm event. The alarm shall then clear.

d. Each workstation shall display the total pending alarms and total unresolved alarms.
e. Each alarm point shall be programmable to disallow the resolution of alarms until the alarm point has returned to its normal state.
f. Alarms shall transmit to the central server in real time except for allowing connection time for dial-up locations.
g. Alarms may be displayed and managed from different windows.

1) Input Status: Overlay status icon with a large blinking icon.
2) Alarm Window: Display name, time, and date in red.
3) Graphic Map Display: Display a steady colored icon representing each alarm input location. Change icon to flashing red when the alarm occurs. Change icon from flashing red to steady red when the alarm is acknowledged.

h. Once an alarm is acknowledged, the operator shall be prompted to enter comments about the nature of the alarm and actions taken. Operator's comments may be manually entered or selected from a programmed predefined list, or a combination of both.
i. For locations where there are regular alarm occurrences, provide programmed comments. Selecting that comment shall clear the alarm.
j. The time and name of the operator who acknowledged and resolved the alarm shall be recorded in the database.
k. Identical alarms from the same alarm point shall be acknowledged at the same time the operator acknowledges the first alarm. Identical alarms shall be resolved when the first alarm is resolved.
l. Alarm functions shall have priority over downloading, retrieving, and updating database from workstations and controllers.
m. When a reader-controlled output (relay) is opened, the corresponding alarm point shall be automatically bypassed.

10. Monitor Display: Display text and graphic maps that include zone status integrated into the display. Colors are used for the various components and current data. Colors shall be uniform throughout the system.

a. Color Code:

1) FLASHING RED: Alerts operator that a zone has gone into an alarm or that primary power has failed.
2) STEADY RED: Alerts operator that a zone is in alarm and alarm has been acknowledged.
3) YELLOW: Advises operator that a zone is in access.
4) GREEN: Indicates that a zone is secure, and that power is on.

b. Graphics:

1) Support 32,000 graphic display maps and allow import of maps from a minimum of 16 standard formats from another drawing or graphics program.
2) Allow I/O to be placed on graphic maps by the drag-and-drop method.
3) Operators shall be able to view the inputs, outputs, and the point's name by moving the mouse cursor over the point on the graphic map.
4) Inputs or outputs may be placed on multiple graphic maps. The operator shall be able to toggle to view graphic maps associated with I/Os.
5) Each graphic map shall have a display-order sequence number associated with it to provide a predetermined order when toggled to different views.
6) Camera icons shall have the ability to be placed on graphic maps, when selected by an operator, will open a video window, display the camera associated with that icon, and provide pan-tilt-zoom control.
7) Input, output, or camera placed on a map shall allow the ability to arm or bypass an input, open or secure an output, or control the pan-tilt-zoom function of the selected camera.

11. Report-Generator Software: Include commands to generate reports for displaying, printing, and storing on removable media. Reports shall be stored by type, date, and time. Report printing shall be the lowest-priority activity. Report-generation mode shall be operator selectable but set up initially as periodic, automatic, or on request. Include time and date printed and the name of operator generating the report. Report formats may be configured by operators.

a. Alarm Reports: Reporting shall be automatic as initially set up. Include alarms recorded by system over the selected time and information about the type of alarm (such as door alarm, intrusion alarm, tamper alarm, etc.), the type of sensor, the location, the time, and the action taken.
b. Access and Secure Reports: Document zones placed in access, the time placed in access, and the time placed in secure mode.
c. Custom Reports: Reports tailored to exact requirements of who, what, when, and where. As an option, custom report formats may be stored for future recall.
d. Automatic History Reports: Named, saved, and scheduled for automatic generation.
e. Cardholder Reports: Include data, or selected parts of the data, as well as the ability to be sorted by name, card number, imprinted number, or by any of the user-defined fields.
f. Cardholder by Reader Reports: Based on who has access to a specific reader or group of readers by selecting the readers from a list.
g. Cardholder by Access-Level Reports: Display everyone that has been assigned to the specified access level.
h. Panel Labels Reports: Printout of control-panel field documentation including the actual location of equipment, programming parameters, and wiring identification. Maintain system installation data within system database so that data are available on-site at all times.
i. History Reports: Custom reports that allow the operator to select any date, time, event type, device, output, input, operator, Location, name, or cardholder to be included or excluded from the report.

1) Initially store history on the server of the host PC.
2) The report shall be definable by a range of dates and times with the ability to have a daily start and stop time over a given date range.

3) Each report shall depict the date, time, event type, event description, and device; or I/O name, cardholder group assignment, and cardholder name or code number.
4) Each line of a printed report shall be numbered to ensure that the integrity of the report has not been compromised.
5) Total number of lines of the report shall be given at the end of the report. If the report is run for a single event such as "Alarms," the total shall reflect how many alarms occurred during that period.

j. Reports shall have the following four options:
1) View on screen.
2) Print. Include automatic print spooling and "Print To" options if more than one printer is connected to the system.
3) "Save to File" with full path statement.
4) System shall have the ability to produce a report indicating status of system inputs and outputs or of inputs and outputs that are abnormal, out of schedule, manually overridden, not reporting, or in alarm.

k. Custom Code List Subroutine: Allow the access codes of system to be sorted and printed according to the following criteria:

1) Active, inactive, or future activate or deactivate.
2) Code number, name, or imprinted card number.
3) Group, Location access levels.
4) Start and stop code range.
5) Codes that have not been used since a selectable number of days.
6) In, out, or either status.
7) Codes with trace designation.

l. The reports of system database shall allow options so that every data field may be printed.
m. The reports of system database shall be constructed so that the actual position of the printed data shall closely match the position of the data on the data-entry windows

12. Training Software: Enables operators to practice system operation, including alarm acknowledgment, alarm assessment, response force deployment, and response force communications. System shall continue normal operation during training exercises and shall terminate exercises when an alarm signal is received at the console.
13. Database management functions shall allow operators to add, delete, and modify access data as needed.

a. The enrollment station shall not have alarm response or acknowledgment functions.
b. Provide multiple, password-protected access levels. Database management and modification functions shall require a higher operator access level than personnel enrollment functions.
c. The program shall provide means to disable the enrollment station when it is unattended, to prevent unauthorized use.
d. The program shall provide a method to enter personnel identifying information into the entry-control database files through enrollment stations. In the case of

personnel identity-verification subsystems. Allow entry of personnel identifying information into the system database using menu selections and data fields. The data field names shall be customized during setup to suit user and site needs. Personnel identity-verification subsystems selected for use with the system shall fully support the enrollment function and shall be compatible with the entry-control database files.

e. Cardholder Data: Provide 99 user-defined fields. System shall have the ability to run searches and reports using any combination of these fields. Each user-defined field shall be configurable, using any combination of the following features:

1) MASK: Determines a specific format with which data must comply.
2) REQUIRED: Operator is required to enter data into field before saving.
3) UNIQUE: Data entered must be unique.
4) DEACTIVATE DATE: Data entered will be evaluated as an additional deactivate date for all cards assigned to this cardholder.
5) NAME ID: Data entered will be considered a unique ID for the cardholder.

f. Personnel Search Engine: A report generator with capabilities such as search by last name, first name, group, or any predetermined user-defined data field; by codes not used in definable number of days; by skills; or by seven other methods.
g. Multiple Deactivate Dates for Cards: User-defined fields to be configured as additional stop dates to deactivate any cards assigned to the cardholder.
h. Batch card printing.
i. Default card data can be programmed to speed data entry for sites where most card data are similar.
j. Enhanced ASCII File Import Utility: Allows the importing of cardholder data and images.
k. Card Expire Function: Allows readers to be configured to deactivate cards when a card is used at selected devices.
l. Access Level expiration: Allow automated activation and deactivation of individual card, credential record, or access levels.

F. System Database:

1. File Management:

a. File management shall include database backup and restoration system, allowing selection of storage media, including CDR, DVD, or USB drive, and designated network resources.
b. Operations shall be both manual and automatic modes. The number of automatic sequential backups before the oldest backup will be overwritten; FIFO mode shall be operator selectable.
c. Backup program shall provide manual operation from any PC on the LAN and shall operate while system remains operational.

2. Access Card/Code Operation and Management: Access authorization shall be by card, by a manually entered code (PIN), or by a combination of both (card plus PIN).

a. Access authorization shall verify the facility code first, the card or card-and-PIN validation second, and the access level (time of day, day of week, date), anti-pass back status, and number of uses last.

b. Use data-entry windows to view, edit, and issue access levels. Access-authorization entry-management system shall maintain and coordinate all access levels to prevent duplication or the incorrect creation of levels.
c. Allow assignment of multiple cards/codes to a cardholder.
d. Allow assignment of up to four access levels for each location to a cardholder. Each access level may contain any combination of doors.
e. Each door may be assigned four distinct schedules.
f. Access codes may be up to 11 digits in length.
g. Software shall allow the grouping of locations to allow cardholder data to be shared by all locations in the group.
h. Visitor Access: Issue a visitor badge for data tracking or photo ID purposes without assigning that person a card or code.
i. Cardholder Tracing: Allow for selection of cardholder for tracing. Make a special audible and visible annunciation at control station when a selected card or code is used at a designated code reader. Annunciation shall include an automatic display of the cardholder image.
j. Allow each cardholder to be given either an unlimited number of uses or a number from one to 9,999 that regulates the number of times the card can be used before it is automatically deactivated.
k. Provide for cards and codes to be activated and deactivated manually or automatically by date. Provide for multiple deactivate dates to be preprogrammed.

3. Security Access Integration:

a. Photo ID badging and photo verification shall use the same database as the security access and may query data from cardholder, group, and other personal information to build a custom ID badge.
b. Automatic or manual image recall and manual access based on photo verification shall also be a means of access verification and entry.
c. System shall allow sorting of cardholders together by group or other characteristic for a fast and efficient method of reporting on, and enabling or disabling, cards or codes.

4. Facility Codes: System shall accommodate up to 2,048 facility codes per Location, with the option of allowing facility codes to work at all doors or only at particular doors.
5. Operator Comments:

a. With the press of one appropriate button on the toolbar, the user shall be permitted to enter operator comments into the history at any time.
b. Automatic prompting of operator comment shall occur before the resolution of each alarm.
c. Operator comments shall be recorded by time, date, and operator number.
d. Comments shall be sorted and viewed through reports and history.
e. The operator may enter comments in two ways; either or both may be used:

1) Manually entered through keyboard data entry (typed), up to 65,000 characters per each alarm.
2) Predefined and stored in database for retrieval on request.

f. System shall have a minimum of 999 predefined operator comments with up to 30 characters per comment.

6. Group:

    a. Group names may be used to sort cardholders into groups that allow the operator to determine the tenant, vendor, contractor, department, division, or any other designation of a group to which the person belongs.
    b. System software shall have the capacity to assign one of 32,000 group names to an access authorization.
    c. Make provision in software to deactivate and reactivate all access authorizations assigned to a particular group.
    d. Allow sorting of history reports and code list printouts by group name.

7. Schedules:

    a. Each schedule consists of a start and stop time for seven days of the week and three holiday schedules. A schedule is assigned to inputs, outputs, or access levels to determine when an input shall automatically arm or disarm, when an output automatically opens or secures, or when access authorization assigned to an access level will be denied or granted.
    b. Up to four schedules may be assigned to inputs and outputs to allow up to four arm or disarm periods per day or four lock or unlock periods per day; up to three holiday override schedules may be assigned to a schedule.
    c. Data-entry window shall display a dynamically linked bar graph showing active and inactive times for each day and holiday, as start and stop times are entered or edited.
    d. System shall have the capacity for 2,048 schedules for each Location.

8. Holidays:

    a. Three different holiday schedules may be assigned to a schedule. Holiday schedule consists of date in format MM/DD/YYYY and a description. When the holiday date matches the current date of the schedule, the holiday schedule replaces the schedule for that 24-hour period.
    b. System shall have the capacity for 255 annual holidays.
    c. Three separate holiday schedules may be applied to a schedule.
    d. Holidays have an option to be designated as occurring on the designated date each year. These holidays remain in the system and will not be purged.
    e. Holidays not designated to occur each year shall be automatically purged from the database after the date expires.

9. Access Levels:

    a. System shall allow for the creation of up to 32,000 access levels.
    b. One level shall be predefined as the Master Access Level. The Master Access Level shall work at all doors at all times and override any anti-pass back.
    c. System shall allow for access to be restricted to any area by reader and by time. Access levels shall determine when and where an Identifier is authorized.
    d. System shall be able to create multiple door and time-zone combinations under the same access level so that an Identifier may be valid during different time periods at different readers even if the readers are on the same controller.

10. User-Defined Fields:

a. System shall provide a minimum of 99 user-defined fields, each with up to 50 characters, for specific information about each credential holder.
b. System shall accommodate a title for each field; field length shall be 20 characters.
c. A "Required" option may be applied to each user-defined field that, when selected, forces the operator to enter data in the user-defined field before the credential can be saved.
d. A "Unique" option may be applied to each user-defined field that, when selected, will not allow duplicate data from different credential holders to be entered.
e. Data format option may be assigned to each user-defined field that will require the data to be entered with certain character types in specific spots in the field entry window.
f. A user-defined field, if selected, will define the field as a deactivate date. The selection shall automatically cause the data to be formatted with the windows MM/DD/YYYY date format. The credential of the holder will be deactivated on that date.
g. A search function shall allow any one user-defined field or combination of user-defined fields to be searched to find the appropriate cardholder. The search function shall include a search for a character string.
h. System shall have the ability to print cardholders based on and organized by the user-defined fields.

G. Tamper Protection:

1. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.3 ACCESS CONTROL SYSTEM HARDWARE

A. Access Control System Units:

1. Description: This category covers head end units for access control systems, providing a means of regulating or controlling physical entry into an area, or access to or use of device by electrical, electronic, and/or mechanical means. Access control systems are investigated as complete configuration based upon manufacturer's specified system components. Access control systems are intended to comply with applicable life safety access and egress requirements.

B. Performance Criteria:

1. Regulatory Requirements:

a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

2. Listing Criteria:

a. Listing Criteria: UL CCN ALVY; including UL 294.

C. Access Control System Server:

1. Access control system server shall meet the minimum recommended requirements of the access control system manufacturer.
2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. RAID Level: RAID 1
b. Mounting: EIA/ECA-310 standard 19-inch rack mount.

D. Access Control System DGPs:

1. Data gathering panels shall meet the minimum recommended requirements of the access control system manufacturer.
2. Source Limitations: Obtain products from a single manufacturer.

E. Access Control System Door Controllers:

1. Manufacturers:

a. AMAG

2. Source Limitations: Obtain products from single manufacturer.
3. Additional Characteristics:

a. Data ports for connection to LAN and downstream controllers.
b. Integral terminal blocks for connection of inputs/outputs to field devices.
c. Controller Inputs:

1) Auxiliary input.
2) Door contact.
3) Request to exit.
4) Cabinet tamper.
5) Power monitor.

d. Controller Outputs:

1) Auxiliary output.
2) Door strike.
3) Door operators.
4) Credential readers.

4. Cable Management: Controllers shall incorporate finger duck raceways between circuit boards. Route all interconnecting cabling through finger ducts. Cabling within controller cabinets may not run more than 6” outside of cabling duct.

5. The intelligent controller shall be an Ethernet ready, fault-tolerant host communication capable for the efficient management of a large network of access panels in any system design. The intelligent controller shall use an RS-232, 2-wire RS-485 or Ethernet link to

connect to a Windows host. The intelligent controller shall be capable of elaborate processes and procedures without host intervention. Once configured, the intelligent controller shall function independently of the host, and shall be capable of controlling access, managing alarms, interfacing with an array of hardware devices, all while providing the decision-making oversight that each system configuration requires. The intelligent controller shall provide centralized biometric template management and support a wide range of reader technologies, including Wiegand, OSDP, magnetic stripe and biometric 2-wire RS-485 connectivity and capable of supporting up to 64 doors in paired and or alternate reader configurations with peripheral interface devices.

6. Controller Operations at a Location:

   a. Up to 64 controllers connected to RS-485 communications loop. Locally operating I/O linking and anti-pass back functions between controllers within the same Location without central-station or workstation intervention. Linking and anti-pass back shall remain fully functional within the same Location even when the central server or workstations are off-line.
   b. In the event of communication failure between the central server and a Location, there shall be no degradation in operations at the controllers at that Location. Controllers at each Location shall be connected to a memory buffer with a capacity to store up to 10,000 events; there shall be no loss of transactions in system history files until the buffer overflows.
   c. Buffered events shall be handled in a first-in-first-out mode of operation.

7. Individual Controller Operation:

   a. Controllers shall transmit alarms, status changes, and other data to the central server when communications circuits are operable. If communications are not available, controllers shall function in a stand-alone mode; operational data, including the status and alarm data normally transmitted to the central server, shall be stored for later transmission to the central server. Storage capacity for the latest 1,024 events shall be provided at each controller.
   b. Controllers shall provide a response to card readers or keypad entries in less than 0.25 second, regardless of system size.
   c. Controllers that are reset, or powered up from a nonpowered state, shall automatically request a parameter download and reboot to their proper working state. This shall happen without any operator intervention.
   d. Initial Startup: When controllers are brought on-line, database parameters shall be automatically downloaded to them. After initial download is completed, only database changes shall be downloaded to each controller.
   e. On failure for any reason, controllers shall perform an orderly shutdown and force controller outputs to a predetermined failure-mode state, consistent with the failure modes shown and the associated control device.
   f. After power is restored, following a power failure, startup software shall initiate self-test diagnostic routines, after which controllers shall resume normal operation.
   g. After controller failure, if the database and application software are no longer resident, controllers shall not restart but shall remain in the failure mode until repaired. If database and application programs are resident, controllers shall immediately resume operation. If not, software shall be restored automatically from the central server.

8. Communications Monitoring:

    a. System shall monitor and report status of RS-485 communications loop of each Location.
    b. Communication status window shall display which controllers are currently communicating, a total count of missed polls in a user configurable time period, and which controller last missed a poll.
    c. Communication status window shall show the type of CPU, the type of I/O board, and the amount of RAM for each controller.

9. Operating systems shall include a real-time clock function that maintains seconds, minutes, hours, day, date, and month. The real-time clock shall be automatically synchronized with the central server at least once a day to ±10 seconds. The time synchronization shall be automatic, without operator action and without requiring system shutdown.

F. Badge Printers and Encoder:
1. Provide one badge encoder integrated with the access control system. Badge encoder must include the following features:
    a. Encode badges with both 125 khz and selected encrypted card technology with unique identity enabling PDX readers to recognize the card as compatible with the population.
    b. Compatible with the provided access control system.
    c. Windows 11 and newer OS compatibility

2. Provide one badge printer capable of printing high resolution imagery on cards in full color. Badge printer must include the following features:
    a. Single-sided badge printing capable
    b. Input hopper capacity of a minimum of 50 cards
    c. Output hopper capacity of a minimum of 25 cards
    d. Full color badge printing in 60 seconds or less.
    e. Ink ribbon with ink capacity for no less than 250 single sided badges printed.
    f. USB Connection
    g. Windows 11 and newer OS compatibility

3. Provide in person training, written and video training on operation of the badge programmer and printer.

G. Access Control System Power Supplies and Battery Chargers

1. Description: This category covers power supplies and battery chargers for access control system units, controllers, input/output interfaces, workstations, printers, and encoders.
2. Performance Criteria:

    a. Listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.

3. Listing Criteria: UL CCN ALVY; including UL 294.
4. Source Limitations: Obtain products from single manufacturer.

5. Additional Characteristics:

    a. Input Voltage: 120 VAC.
    b. Output Voltage: 12 to 24 VDC.
    c. Network connection for remote supervision, management, and testing.
    d. Enclosure lock with tamper switch and monitoring.
    e. Built-in battery charger.
    f. Provide batteries sufficient to power access control system and connected door hardware for a minimum of 8 hours based on an average of 2 transactions per door per hour. Provide power draw and battery backup calculations for each panel.

6. Accessories:

    a. DIN rails for mounting.

2.4 ACCESS CONTROL READERS AND DEVICES

A. Credential Readers

1. Description: Electronic devices that read one or more types of access credentials and are part of overall access control system. These devices read and transfer credential info to access control system for control of door locks and other access control components.
2. Performance Criteria:

    a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

    b. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes authenticating the credential card until a response signal is generated.

    c. Listing Criteria:

        1) UL CCN ALVY; including UL 294.
        2) Plastic Enclosure: UL CCN QMFZ2; including UL 94.

    d. General Characteristics:

        1) Visual LED indication of credential authorization
        2) Reader Types:

            a) Mullion Mount
            b) Standard Wall Mount
            c) Standard Wall Mount with PIN Pad

        3) Transmit Frequency: 2.4 GHz
        4) Certified Secure Element Hardware
        5) Native OSDP Secure Channel Capability

6) Operating Voltage: 12 VDC
7) Visual
8) Housing: Molded Polycarbonate
9) Environmental Rating: IP65

3. Manufacturer:
   a. HID
   b. Approved Equal

2.5 ACCESS CONTROL CREDENTIALS

A. Access Control Cards

1. General Characteristics:

   a. Reference Standards:

      1) Personal Identity Verification (PIV): FIPS PUB 201-2.
      2) Physical: IEC 7810; IEC 10373; IEC 7816 for contact cards; and IEC 14443 for contactless cards.
      3) Functional: UL 294; IEC 60839-11-1; and IEC 60839-11-2.
      4) Material Durability: INCITS 322.

   b. Format: Customizable, including artwork.
   c. Credential shall be multi-class card that includes the following technologies:

      1) 125 kHz Proximity
      2) 13.56 MHz iCLASS or approved equivalent
      3) Technology of Selected Card Reader

2.6 SURGE AND TAMPER PROTECTION

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor-entry connection to components.

   1. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, balanced magnetic switches and other system components must initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station control-unit alarm display must identify tamper alarms and indicated locations.

2.7 PATHWAYS

A. Support of Open Cabling in Equipment Rooms: NRTL labeled for support of low voltage cabling, designed to prevent degradation of cable performance and pinch point that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

2.8 LOW VOLTAGE CABLE

A. Access Control Composite Cable (banana peel type)

1. Shall include (4) individual door device cables, one each for:

a. Card reader
b. Lock power
c. Door contact
d. Request to exit (REX) switch

2. Yellow in color.
3. As recommended by Access Control System manufacturer.
4. Plenum rated cabling to be provided as required by NEC code.

B. Systems Cabling

1. Supply other cable types as required for peripheral systems wiring.
2. As recommended by Access Control System manufacturer.
3. Any field wiring (outside of equipment rooms) shall be yellow in color.
4. Plenum rated cabling to be provided as required by NEC code.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS CONTROL SYSTEM

A. Description: Access control system provides a means of regulating or controlling physical entry into an area, or access to or use of a device by electrical, electronic, and/or mechanical means. Typical access control system includes a card reader at a controlled door, which reads a user credential and sends the collected data to a centrally located DGP over the cabling infrastructure. DGP may hold a user database onboard or may communicate with a user database over the network. If user is authorized for access at a controlled door, DGP signals the electronic lock at the door to unlock. If user credential is not authorized according to user database, the door remains locked and access is denied. In addition to card readers and electronic locks, access control systems may include various other connected devices programmed for a desired function.

B. Performance Criteria:

1. Regulatory Requirements:

    a. Components listed and labeled in accordance with NFPA 70 and NFPA 72, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
    b. Comply with NFPA 1, NFPA 730, NFPA 731, and ICC IBC.
    c. Certification: Provide certificate, authorized under UL Certification Service, that access control system installation complies with installation requirements of UL CCN ALOV.

2. Listing Criteria: UL CCN ALOV and UL CCN ALVY; including UL 294.
3. Consult Architect for resolution of conflicting requirements.

C. Selection of Access Control System Components:

1. Source Limitations: Obtain components for access control system from sources approved by manufacturer warranting performance of entire system.

D. Special Techniques:

1. Comply with manufacturer's published instructions.
2. Mounting Heights: Mount field devices in accessible locations in accordance with United States Access Board ADA-ABA Accessibility Guidelines standards.

E. Interfaces with Other Work:

1. Coordinate installation of new access control system components with existing conditions.

F. Systems Integration:
1. Coordinate with Section 282000 "Video Surveillance" for integrating access control system with video surveillance controls.

3.2 CABLING

A. Comply with NECA 1, “Good Workmanship in Electrical Construction.”

B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

C. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

D. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

E. If required, install end-of-line resistors at the field device location and not at the controller or panel location.

3.3 CABLE APPLICATION

A. Comply with TIA 569-B, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-485 Cabling: Install at a maximum distance of 4,000 ft. (1220 m).

D. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft. (75 m), and install No. 20 AWG wire if maximum distance is 500 ft. (150 m).
3. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 500 ft.

F. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft.

3.4 GROUNDING

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Bond shields and drain conductors to ground at only one point in each circuit.

D. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet

3.5 IDENTIFICATION

A. Develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. At completion, cable and asset management software shall reflect as-built conditions.

D. A copy of wire termination designations shall be placed inside the cabinet door cover with real world logical locations and associated designation ID’s.

E. Provide serial numbers, MAC addresses, frequency channels, time channels and duty cycles where applicable for all installed devices.

3.6 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 6 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10% of the calculated battery

operating time. Provide special equipment and software if testing requires special or dedicated equipment.

a. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 STARTUP SERVICE:

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.9 ADJUSTING

A. Control Sensor Adjustments: Adjust control devices to suit actual occupied conditions.

1. For proximity motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.10 PROTECTION

A. After installation, protect access control system components from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.11 MAINTENANCE

A. Control Sensor Readjustments: When requested within **12** months from date of Substantial Completion, provide on-site assistance in readjusting system to suit actual occupied conditions. Provide up to **two** visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 28 10 00

SECTION 28 20 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

B. Related Requirements:

1. Section 28 13 00 "Access Control System Software and Database Management" to integrate access control system interface and control.

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
3. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
4. UPS: Sizing calculations.
5. Wiring Diagrams: For power, signal, and control wiring.

C. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for cameras, camera-supporting equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Product Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, monitors, network video recorders, network switches, and control-station components to include in emergency, operation, and maintenance manuals.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F (16 to 29 deg C) and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F (2 to 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F (minus 34 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph (137 km/h) and snow cover up to 24 inches (610 mm) thick. Use NEMA 250, Type 4X enclosures.
4. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
5. Corrosive Environment: System components subject to corrosive fumes, vapors, and wind-driven salt spray in coastal zones. Use NEMA 250, Type 4X enclosures.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

B. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened

or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.3 CAMERAS

A. Manufacturers:

1. Axis Communications
2. Approved Equal

B. Fixed Dome Cameras:
1. Image Sensor: Progressive scan RGB CMOS 1/2.8”
2. Resolution: 1920x1080 w/ wide dynamic range and Lightfinder 2.0
3. Video Compression: H.265, Zipstream
4. Power: PoE IEEE 802.3af/802.3at Type 1 Class 3; Typical 4.8 W, Maximum 10.7 W
5. Housing: IK10 impact-resistant casing
6. Dome: Polycarbonate hard-coated dome
7. Lens: Varifocal, 3.4-8.9 mm, F1.8 w/ remote focus and zoom
8. Day and Night: Automatically removeable infrared-cut filter
9. Illumination: Optimized infrared LEDs
10. Axis Camera Application Platform
11. Model:
    a. Axis P3265-LVE
    b. Approved Equal

C. Pan-Tilt Zoom Color Dome Camera:
1. Image Sensor: 1/2.8” progressive scan CMOS.
2. Lens: Motorized, 4.25-170 mm F1.6-4.95.
    a. Autofocus and auto-iris.
3. Day/night automatically removable infrared-cut filter.
4. Minimum Illumination:

a. Color: 0.10 lux at 30 IRE, F1.6
b. B/W: 0.002 lux at 30 IRE, F1.6.
c. Color: 0.15 lux at 50 IRE, F1.6
d. B/W: 0.003 lux at 50 IRE, F1.6

5. Pan/Tilt Zoom:
   a. Pan: 360° endless.
   b. Tilt: 220°
   c. Zoom: 40x optical, 12x digital, total 480x zoom.
6. Video Compression: H.264 Baseline, H.265 Main profile.
7. Maximum Resolution: 1080p, 1920 x 1080.
8. System Integration: Supports Axis Camera Application Platform (ACAP).
   a. Video Analytics: Evolon Edge.
9. Casing: IP66, IP67, NEMA 4X and IK10-rated.
10. Power: High PoE 60W
    a. Typical: 14 W
    b. Maximum: 51 W
11. Operating Conditions:
    a. 30 W: -4° F to 122° F
    b. 60 W: -58° F to 122° F
12. Model:
    a. Axis Q6075-E

D. Fixed Color Box Camera:
1. Image Sensor: Progressive scan RGB CMOS 1/1.8”
2. Resolution: 2688x1512 w/ wide dynamic range and Lightfinder 2.0
3. Video Compression: H.265, Zipstream
4. Power: PoE IEEE 802.3at Type 2 Class 4; Typical 11.2 W, Maximum 25.5 W
5. Lens: Varifocal, 3.9-10 mm, F1.5 w/ remote focus and zoom
6. Day and Night: Automatically removeable infrared-cut filter
7. Illumination: Optimized infrared LEDs
8. Axis Camera Application Platform
9. Model:
   a. Axis P3265-LVE
   b. Approved Equal

2.4 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera and lens.

1. Enclosure: NEMA 250, Type 4X

2.5 CAMERA-SUPPORTING EQUIPMENT

A. Conduit Back Box

1. Model:
   a. Axis T9401P
   b. Approved Equal

B. Pendant Wall Mount Kit

1. Pendant
   a. Model:
      1) Axis T94K01D
      2) Approved Equal

2. Wall Mount
   a. Model:
      1) Axis T91D61
      2) Approved Equal
3. Pole Mount
   a. Model:
      1) Axis T91B47
      2) Approved Equal

2.6 VIDEO SURVEILLANCE WORKSTATIONS

A. Security Workstation:

1. Maximum number of 25 camera panes per client.
2. 4th Generation Intel Core i7-4770 or better
3. 16 GB of RAM or better
4. Windows 10 Pro/Enterprise 64-bit operating system
5. Microsoft .NeT 4.7 Framework
6. DirectX 11.0 or newer
7. 240 GB Solid State Drive for OS and Milestone Applications
8. GbE network interface card
9. NVIDIA GeForce GTX 1060 6 GB video card or better

2.7 NETWORK VIDEO RECORDERS

A. External storage or internal minimum of 2 TB RAID storage. Size recorders to provide 30 days storage for all connected cameras plus 25%.

1. Video and audio recording over TCP/IP network.
2. Video recording of H.265 dual streams.
   a. See schedules for recording requirements of primary stream
   b. Record secondary stream 24/7 at 4 FPS.
3. Duplex Operation: Simultaneous recording and playback.
4. Continuous and alarm-based recording.
5. Full-Featured search capabilities: Search based on camera, time, date, motion and/or event.
6. Automatic data replenishment to ensure recording even if network is down.
7. Digital certification by watermarking.
8. Internal RAID storage of up to 64 TB.
9. Capable of adding external RAID storage up to 64 TB for models with no internal storage.

10. Full integration with LAN, Intranet, or Internet through standard Web browser or video management software.
11. Integrated Web server FTP server functionality.
12. Supports up to 64 devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WIRING

A. Comply with requirements in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Install cables in raceways unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

E. For communication wiring, comply with the following:

1. Section 271313 "Communications Copper Backbone Cabling."
2. Section 271323 "Communications Optical Fiber Backbone Cabling."
3. Section 271513 "Communications Copper Horizontal Cabling."
4. Section 271523 "Communications Optical Fiber Horizontal Cabling."

F. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.3 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras level and plumb.

B. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

F. Avoid ground loops by making ground connections only at the control station.

G. Identify system components, wiring, cabling, and terminals according to Section 270553 "Identification for Communications Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:

    a. Prepare equipment list described in "Informational Submittals" Article.
    b. Verify operation of auto-iris lenses.
    c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.

d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
e. Set and name all preset positions; consult Owner's personnel.
f. Set sensitivity of motion detection.
g. Connect and verify responses to alarms.
h. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

E. Video surveillance system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.6 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION 28 20 00

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 31 00 - FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Furnish all labor, materials, and equipment for a fully operational fire alarm system in full compliance with the applicable NFPA standards and all other codes, regulations and laws applicable to the work, and in full compliance with the intent of the plans and specifications, including all work inferable from same.

B. Section includes:
   1. Fire alarm control unit (FACU) (existing).
   2. Notification Appliances.
   3. Input and output modules.
   4. Wiring and connections.
   5. Remote annunciator.
   6. Surge protective devices.
   7. System programming.
   8. System testing.

C. Pay for all necessary construction permits related to the fire alarm system.

D. Related Sections:
   1. SECTION 26 05 10 – BASIC ELECTRICAL REQUIREMENTS
   2. SECTION 26 05 19 – LOW-VOLTAGE ELECRICAL POWER CONDUCTORS AND CABLES.
   3. SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
   4. SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS.
   5. SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS.

1.03 REFERENCES:

A. Applicable Codes and Standards (latest edition or as adopted by local jurisdiction):
   1. 2022 Portland Building Code
   2. 2022 PFC (Portland Fire Code)
   3. Local Codes including local policies, interpretation, and standards.
   4. Americans with Disabilities Act (ADA).
   5. FM Global (FM):
      a. FM Approvals - Approval Guide.
      b. Property Loss Prevention Data Sheets.
   6. NFPA (National Fire Protection Association) - Latest edition or as adopted by local jurisdiction:
      a. NFPA 70 - National Electrical Code (NEC) (2017).
      b. NFPA 72 - National Fire Alarm and Signaling Code (2019).
      c. NFPA 170 – Standard for Fire Safety and Emergency Symbols (2018)

7. Underwriters Laboratories (UL): Comply with provisions of UL safety standards pertaining to fire alarm systems; provide products and components which are UL-listed and labeled.
8. Fire Protection equipment directory.
    a. Edwards: EST3 Seismic Application Guide
9. FCC regulation Part 15, Section 15

1.04 DEFINITIONS:

A. References to the Fire Alarm Technician in this SECTION shall mean:
    1. A qualified fire protection technician certified at Level IV with the National Institute for Certification in Engineering Technologies (NICET) in Fire Alarm Systems.
B. References to the Fire Alarm Installer in this SECTION shall mean:
    1. A qualified fire protection technician certified at Level II with the National Institute for Certification in Engineering Technologies (NICET) in Fire Alarm Systems.
C. References to the Manufacturer's Authorized Representative in this SECTION shall mean:
    1. A qualified fire protection technician certified at Level III with the National Institute for Certification in Engineering Technologies (NICET) in Fire Alarm Systems, trained and authorized by the fire alarm equipment manufacturer on the installation, programming and testing of their equipment. Acceptable Providers are:
        a. Convergint Technologies
        b. GB Manchester
        c. Performance Systems Integration (PSI)
        d. Or Pre-bid approved equal
D. References to the Fire Alarm System Service Provider (FASSP) in this SECTION shall mean:
    1. Performance Systems Integration (PSI).
        a. Scott LeClair (primary)
            (1) Email: scott.leclair@psintegrated.com
            (2) Phone: (503) 403-8910
        b. Lauren Major (alternate)
            (1) Email: lauren@psintegrated.com
            (2) Phone: (541) 510-5518
E. References to the Fire Alarm Control Unit in this section shall mean:
    1. A dedicated function fire alarm control unit provided for monitoring of the emergency fuel shut off system and other functions as indicated on the drawings.

1.05 PERFORMANCE REQUIREMENTS:

A. The system shall be a complete, addressable, remote supervising station system using a fire alarm communicator with remote annunciator notification conforming to NFPA 72.
B. Fire alarm system design shall be approved by FASSP and authorities having jurisdiction.

1.06 ACTION SUBMITTALS:

A. Refer to DIVISION 01 for administrative and procedural requirements for submittals.
B. Pre-Design Narrative:
    1. Prepare pre-design narrative of anticipated system design. Include:
        a. Proposed point of connection to the existing fire alarm system network.
        b. Existing FACU requirements or impacts.
        c. Types of monitoring modules and uses.

d. Audible/visual alarm devices and general locations of use.

C. Product Data: Provide a bill of materials for all products utilized. For each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.
3. Material cut sheets for each cable and conductor and cable type used.
4. Material cut sheets shall be annotated to indicate the exact model, configuration, finishes, and other options that will be provided. Submit device power requirements. Cut sheets with multiple models, configurations and options that are not annotated will not be accepted. Outdated or poorly reproduced cut sheets will not be accepted.

D. Shop Drawings: Prepare working plans, material cut sheets, and calculations for the complete fire alarm system in accordance with the documentation requirements of NFPA 72. Shop drawing submittals shall include, but not be limited to, the following:
1. Prepare shop drawings of the system design utilizing AutoCAD or Revit with the Port's standard fire alarm legend and current project backgrounds provided by the Port or FASSP. Drawings shall be in accordance with the latest version of the Port's CAD and BIM Standards Manual, available for download on the Port's public website at www.portofportland.com.
2. Provide a fully populated fire alarm device schedule utilizing the Port's template, available at www.portofportland.com.
3. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
4. Shop drawings shall indicate coordination with FASSP for drawing scale and drawing numbers.
5. Employ the services of a Fire Alarm Technician. The Fire Alarm Technician shall prepare the fire alarm system shop drawings and calculations for submittal.
6. Drawings showing equipment/device locations, conduit sizes, logic diagrams, and point-to-point field wiring diagrams of the entire fire alarm system.
7. Name of protected premises, owner, and occupant (where applicable), name of installer or contractor, location of protected premises, device legend in accordance with NFPA 170, and date of issue and any revisions.
8. Battery calculations and voltage drop calculations.
9. Interface of fire safety functions, and programming sequence of operations.
10. Scaled floor plan drawings which include floor identification, point of compass, graphic scale, all walls and doors, point-to-point connections, circuit identification, all partitions extending to within 10 percent of the ceiling height (where applicable), room occupancy descriptions, fire alarm device/component locations, locations of fire alarm primary power connection(s), locations of monitor/control interfaces to other systems, conduit routing, type and number of fire alarm system components/devices identified to each circuit, type and quantity of conductors and conduit (if used) for each circuit, information regarding types of construction to verify correct device location, details of ceiling height, and type of construction.
11. Shop drawing plans shall be drawn at a minimum scale of 1/8" = 1'-0".
12. Fire alarm riser diagrams which include the general arrangement of the system in building cross-section, type, number and identification of circuits in each riser, and type and number of fire alarm system components/devices on each circuit, type and quantity of conductors and conduit (if used) for each circuit.
13. Control unit wiring diagrams for all control equipment (i.e., equipment listed as either a control unit or control unit accessory), power supplies, annunciators, and battery

chargers, and which also includes identification of the control equipment depicted, all field wiring terminals and terminal identification, all circuits connected to field wiring terminals and circuit identification, all indicators and manual controls including the full text of all labels, all field connections to supervising station signaling equipment, and fire safety control interfaces.

14. Information on termination types and raceway to be used.
15. The shop drawings, including resubmittals, shall be submitted as a complete submittal package including, but not limited to, shop drawings/working plans, annotated cut sheets, and calculations. Partial submittals and submittals not fully complying with the requirements and recommended practices of NFPA 72 and this specification will be returned disapproved without review.
16. Shop drawings shall be wholly generated and coordinated by the Fire Alarm Subcontractor. Partial or complete reproductions of the Owner's drawings will not be accepted.
17. Shop drawings resubmittals shall be accompanied by a response letter addressing each comment in the Owner's review of the shop drawings. Changes to the working plans shall be clouded to indicate the revised area and annotated to indicate the revision number and revision date.
18. Submit shop drawings, cut sheets, and calculations to the Port of Portland for review.

E. Submit a fire alarm system acceptance test procedure detailing the procedures to be followed for testing of the control equipment, wiring systems, devices, and accessories. Identify each piece of control equipment, device, appliance and circuit to be tested. Describe the test procedure for each item. Identify all equipment and personnel required for the testing. Example test plans and forms describing all hardware and software validation test methods and procedures.

F. Obtain all approvals prior to purchasing equipment or beginning installation.

G. The subcontractor assumes sole responsibility for purchasing equipment or beginning installation before all approvals are obtained. No change orders will be awarded due to purchasing equipment or beginning installation prior to obtaining approvals.

H. PDX Maintainable Fire Alarm Drawings (AutoCAD or Revit):
   1. Upon program download completion, provide to the FASSP CAD files reflecting all additions, deletions, and modifications made to the system. The FASSP shall incorporate the changes to the PDX Maintainable Fire Alarm drawings set.

I. Operation and Maintenance Data:
   1. In addition to items specified in Section 013300, include the following:
      a. Equipment tested.
      b. Required frequency of testing and inspection of installed components.
      c. Requirements and recommendations related to results of maintenance.
      d. Manufacturer’s user training manuals.
      e. Updated shop drawings indicating as-built conditions.
      f. Bill of materials.
      g. Certificate of completion.
      h. Software and Firmware Operational Documentation:
         (1) Program Software Backup: Electronic SDU
         (2) Device address list.
         (3) Screenshots of software application and modified graphic screens in electronic PDF format.

1.07 INFORMATION SUBMITTALS:

A. Subcontractor qualifications: The Fire Alarm subcontractor shall be a qualified Fire Alarm Contractor, licensed and regularly engaged in the installation of fire alarm systems of similar size and complexity. Submit license information and proof of successful completion of three projects of similar size and scope.

B. Designer qualifications:
   1. Submit qualifications of Fire Alarm Technician.
   2. Submit qualifications of Fire Alarm Installer.
   3. Submit qualifications of Manufacturer's Authorized Representative.

1.08 CLOSEOUT SUBMITTALS:

A. Submit operations and maintenance manuals in accordance with DIVISION 01. In addition to items specified in DIVISION 01, provide documentation in accordance with the documentation requirements of NFPA 72. Include as-built drawings, material cut sheets, calculations, and a copy of the site-specific software.

B. Submit all field test data per NFPA 72 and specifications.
   1. Submit NFPA 72 System Record of Completion and applicable Supplementary Records of Completion.
   2. Submit NFPA 72 System Record of Inspection and Testing and applicable Supplementary Records of Inspection and Testing.

C. Submit complete warranty information.

1.09 QUALITY ASSURANCE:

A. Design and install fire alarm systems in accordance with the applicable NFPA standards, locally adopted building code, fire code, and other local policies, interpretations and standards as listed in Part 1 References.
   1. If there is a conflict between the reference codes or standards and this SECTION, it is the Subcontractor's responsibility to notify the Owner in writing. The most stringent requirement, as determined by the Owner shall apply.

B. Compliance with referenced NFPA standards is mandatory. This includes advisory provisions listed in the appendices of such standards, as though the word "shall" had been substituted for the word "should" wherever it appears.

C. Installer Qualifications:
   1. The Subcontractor for the fire alarm installation shall be a qualified Fire Alarm Subcontractor, regularly engaged in the installation of fire alarm systems for a minimum of 5 years with required state and local licenses.
   2. The Subcontractor's responsibilities include designing, fabricating, installing and programming the fire alarm system and providing professional design and engineering services needed to assume engineering responsibility.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports shall be by a qualified Fire Alarm Technician.
      b. The Subcontractor shall maintain a qualified Fire Alarm Installer on-site during installation.

D. Manufacturer's Representative: Provide the services of a certified representative or technician trained by the manufacturer of the system, experienced in the installation and operation of the type of system provided. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the Owner's personnel in the system operation, maintenance and programming.

E. FASSP: Furnishing necessary programming, start-up, and support in testing of new point-addressable loops and devices to ensure fire detection and transmission of all automatic and manual alarms and supervisory, trouble, and monitor signals to the Port's existing fire alarm system.

PART 2 - PRODUCTS

2.01 GENERAL:

A. All equipment shall be Listed by Underwriter's Laboratories and included in the latest edition of the U.L. Fire Protection Equipment directory or Approved by FM Global and listed in the FM Approvals - Approval Guide.
B. All materials shall be approved by FM Global and listed in the FM Approvals - Approval Guide.
C. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
D. All components provided shall be listed for use with the selected system.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 MANUFACTURERS:

A. Fire alarm system control equipment, devices, appliances, components, and accessories may be provided by Edwards to meet this specification.

2.03 FIRE ALARM AND DETECTION SYSTEMS:

A. General: Provide an addressable monitoring system using an existing FACU and an FAA with products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; constructed in accordance with published product information and as required for complete installation. Provide fire alarm and detection systems for applications indicated.
B. The fire alarm system shall provide operation of detection devices, local annunciation, auxiliary control functions and monitoring of systems.
C. System Wiring and Supervision:
    1. Provide Class B initiating device circuits (IDC).
    2. Provide Class B notification appliance circuites (NAC).
    3. Provide Class B signaling line circuit (SLC).
    4. Provide circuits with a minimum Pathway Survivability Level 1.
D. Power Supplies: Provide system for operation on 120Vac power supply from the building electrical system. Fire alarm systems shall be power limited, operating on 24 VDC.
    1. Provide battery back-up as secondary power supply. Provide back-up battery and battery charger each with 20% spare capacity for future use. Design battery back-up to take over supply to system instantaneously. Provide battery with adequate capacity to be capable of operation of system for the greater of the following:
        a. 24 hours under normal supervisory (nonalarm) conditions and then for 15 minutes under alarm conditions.
    2. Battery capacity requirement shall be met regardless of whether an emergency power generator is provided as part of the project.
    3. The battery charger shall completely recharge batteries within 48 hours.

4. Following restoration to normal AC power, the trouble indicators shall be automatically reset.

E. Required System Features:
1. Refer to the functional matrix on the drawings.
2. Monitor Tamper switches and water switches.
3. Monitor the diesel fire pump.

F. Wiring System Materials: Provide basic wiring materials which comply with SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS.
1. Provide wire and cable in accordance with requirements of NFPA 70 and the FACU manufacturer.
2. Minimum conductor size shall be 16 AWG.
3. Provide shielded conductors for SLC's where recommended by the manufacturer or otherwise required due to other building systems or construction. Communications issue resulting from interference will be considered a deficient installation to be corrected at no additional cost.
4. Conductors shall be solid except those used in circuits requiring shielding.
5. Provide conductors which are listed and approved for fire alarm usage.
6. Above-grade Conduit shall be electrical metallic tubing (EMT) or rigid metal conduit (RMC).
7. Minimum conduit size shall be ¾ inch.
8. Fittings and seals shall be metallic suitable for use with the conduit type.
9. Wiring connections shall be made at screw terminals at individual devices or using insulated barrier terminal strips. Wire nuts, spring loaded connectors, and similar devices are not permitted.

G. Fire Alarm Control Equipment (FACU panels):
a. Existing Fire Alarm control Panel is Edwards and is located in the PDC building.

H. Initiating Devices
1. All alarm initiating devices shall be assigned a unique address which is not assigned by their position in the circuit. The system shall allow the future addition of addressable initiating devices by tee-tapping into any point in the circuit.
2. Addressable initiating devices shall prohibit the insertion of non-addressable devices.

I. Notification Appliances
1. Horn/strobe: Provide manufacturer's standard construction, 24VDC, fire alarm horn with following features. Strobe shall comply with UL 1971.
a. Strobe
(1) Manufacturer's standard construction alarm lights.
(2) Clear lens
(3) Flash intensity, rate and duration shall comply with NFPA 72.
b. Horn:
(1) Coded
(2) Surface mounted outdoors. (Outdoor units shall be weatherproof).
(3) Electronic Tone. Electromechanical designs are not acceptable.

J. System Accessories
1. Addressable Input Modules (AIMs):
a. Model: Edwards SIGA-CT1, no substitutions.
b. Input modules shall include an LED that changes states to indicate an alarm or supervisory condition. Module LED's shall be visible without removal of covers.

c. Monitor modules with multiple addresses and a single LED indicator are not acceptable. Multi-address modules with LED indicators for each input and address are acceptable when mounted in cabinet with all LED's visible without removing cover.

2. Addressable Output Modules (AOMs):
   a. Same manufacture as the FACU
   b. Output modules shall include an LED that changes states to indicate an activated condition. Module LED's shall be visible without removal of covers.
   c. Modules with multiple addresses and a single LED indicator are not acceptable. Multi-address modules with LED indicators for each output and address are acceptable when mounted in cabinet with all LED's visible without removing cover.
3. Surge Protective Devices:
   a. For use on IDC, SLC and dialer circuits
      (1) UL 497A/497B
4. Remote Annunciator (FAA): Provide manufacturer's standard construction annunciator that mimics FACU.
   a. UL listed.
   b. Alphanumeric display and LED indicating lights.
   c. Keyed security.
   d. Capable of acknowledging, silencing and resetting.
   e. Local piezo sounder.
   f. Indicates alarm, trouble, supervisory conditions.
   g. Mounting: Flush cabinet, NEMA 250, Type 1.
   h. Enclosure:
      (1) Visual indicators of FACU status shall be visible without opening the key-locked cover.
      (2) Locks: BHMA A156.11, E07121. Lock cylinders and keying where noted:
      (3) Equip locks with cylinders with full size interchangeable core pin tumbler inserts. Furnish only temporary inserts for the construction period. Permanent inserts will be furnished and installed by the Port.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 DELIVERY, STORAGE, AND HANDLING:

A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.

B. Store fire alarm equipment in a clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

3.03 GENERAL:

A. Furnish and install a complete and fully operational fire alarm system as described herein and as shown on the drawings.

B. Equipment shall be installed and wired in accordance with this specification, project drawings and approved shop drawings.
C. Provide all new wiring, conduit, junction boxes and outlet boxes required for the system, including connections to initiating, indicating and control devices furnished by others. Connections to other systems shall be done by the suppliers of those systems.
D. The Fire Alarm Installer shall oversee the fire alarm installation and shall be on site during all fire alarm system work.

3.04 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:

A. Install wiring, raceways, and electrical boxes and fittings in accordance with SECTION 26 05 33 – RACEWAYS, BOXES, SLEEVES, SEALS AND FITTINGS FOR ELECTRICAL SYSTEMS
B. Install all wiring in conduit.
C. Support conduit in accordance with the NEC and Division 26.
    1. Tension only hangers are not permitted (for example, batwings).
    2. Flexible conduit is permitted only where connecting to devices located on fire suppression equipment such as flow and tamper switches.
D. Where possible, install wires and cables without splices. Make connections and splices at terminal strips in cabinets or at equipment terminals. Wire nuts are prohibited.
E. Ground one end of shielding on circuits with shielded conductors.

3.05 INSTALLATION OF FIRE ALARM SYSTEMS:

A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of the NEC.
B. Fire Alarm FAAs:
    1. Mount the FAA enclosure with the top of the cabinet 72 inches above the finished floor or center the cabinet at 63 inches, whichever is lower. The FAA shall be installed in accordance with the manufacturer’s guide for seismic applications, EST3 Seismic Application Guide.
    2. Paint the handles of the dedicated circuit breakers feeding fire alarm panels red and install handle locks.
    3. Within the panel, non-power limited wiring shall be properly separated from power limited circuits.
C. Addressable Modules
    1. Install modules in backbox or manufacturer provided enclosure with LED visible without cover removal.
    2. Install the module within 3 feet from the device controlled.
    3. Orient the device mounting for best maintenance access.
D. Alarm Notification Appliances:
    1. Install notification appliances as indicated on the drawings, spaced in accordance with NFPA 72.
    2. Install wall mounted audible alarms not less than 90 inches above finished floor nor less than 6 inches below ceiling.
    3. Install wall mounted visible alarm strobes with the entire lens between 80 and 96 inches above finished floor.
    4. Mount appliances at uniform heights.
    5. Outdoor notification appliances shall be NEMA 4X, IP56 rated and shall be installed with suitable weatherproof back box, seals and gaskets.

E. Wiring: Wiring of fire alarm system is work of this Section but is not specifically detailed on drawings.
   1. Complete wiring in accordance with the NEC and the manufacturer's requirements. Consistently color code wiring throughout the system and install per manufacturer's point-to-point wiring diagram. Determine exact number of wires for each fire area zone from number and types of devices installed. Connect each device with sufficient wiring to complete its intended operation.
   2. Size all raceway per the NEC. Minimum sizes shall be as specified in this SECTION.
   3. All fire alarm circuits shall be supervised. Provide end-of-line resistors where required to supervise conventional device circuits, etc.
   4. Program the system to function properly and according to the operational matrix indicated on the drawings.
   5. Locate addressable devices only in conditioned spaces.
   6. Install surge suppressors on all 120 VAC power supplies to fire alarm equipment and on fire alarm circuits entering or leaving the building in a dry, climate controlled environment. Ground surge protection devices in accordance with the manufacturer's recommendations.
   7. Externally label all panels (FAA, etc.) to match fire alarm as-built plans.
   8. Identify all conductors with permanent markings at each device and panel.

F. Coordinate with the Owner's representative and FASSP to verify the correct designation for each initiation point prior to final system programming. All final custom messages shall be as directed by Owner. Additional reprogramming required as a result of poor coordination with the Owner's representative shall be reprogrammed at no additional cost to the Owner.

G. Fire alarm devices shall be installed and activated within 48 hours of system programming and downloading the program changes to the FACU network**.** If devices are not activated within that timeframe, the Subcontractor shall, at its own expense, coordinate with the FASSP to restore the system programming to the condition that it was before making the programming changes.

H. Programming: Final system software configuration shall be verified in the field by the system supplier coordinating with the Owner and the FASSP. The system shall include all programming required to provide a proper functioning system as described herein.
   1. Automatic Operation Functions:
      a. Upon actuation of any fuel shutdown switch, the following shall automatically occur:
      b. The alarm condition shall be annunciated visually by a flashing red "Common Alarm" LED in the FACU. Intelligent circuits shall indicate the appropriate circuit and device in alarm via unique LEDs or a numeric LED display of the appropriate circuit and device number.
      c. Activate a signal to the supervising station using the FAC.
   2. Manual Operation Functions:
      a. At any time, even without an alarm condition on an initiating circuit, the operator shall have the following manual capabilities at the FACU using the user interface located behind a key-locked cover:
      b. Initiate the general alarm signal.
      c. Silence the local audible signal. This shall also cause the LED(s) to cease flashing and to be on continuously.
      d. Silence the alarm signals.

e. Disable the central station (Remote Station) transmitter.
f. Reset the FACU after all initiating devices have been restored to normal.
g. Disconnect any individual initiating or indicating circuit from the alarm sequence. This action shall light a "Disconnect" LED and cause a trouble condition.
h. Perform a complete operational test of the system microprocessor with a visual indication of satisfactory communications with each board.
i. Test all panel LEDs for proper operation without causing a change to the condition on any zone.
j. It shall be possible to command test, reset, and silence the alarm from both the FACU and the main operating console.

3.06 INSTALLATION OF BASIC IDENTIFICATION:

A. Install electrical identification in accordance with SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS and this SECTION.
B. All junction and pulling box covers shall be factory finished or painted red and shall be identified in a permanent and legible manner to indicate the zone and circuit that it contains.
   1. Hand lettering and adhesive backed stick-on lettering such as Dymo or Kroy tape are not acceptable.
C. All detection and terminal devices shall be identified in a permanent and legible manner to indicate the device zone and address keyed to the posted operations and maintenance instructions. Hand lettering and adhesive backed stick-on lettering such as Dymo or Kroy tape are not acceptable. Use labels such as:
   1. FS## (Flow Switch)
   2. CM## (control module)
D. All system controls shall be permanently labeled with red plastic labels with engraved white letters.
E. All wiring shall be labeled.
   1. SLC wiring shall be labeled using the following format:
      a. Input (from previous device on SLC): "SLC from FS##" or "SLC from FACU"
      b. Output (to next device on SLC): "SLC to FS##" or "SLC to FACU"
F. Label each fire alarm control unit the panel location, number and circuit number powering the equipment.
G. Label batteries with the date of installation.

3.07 FIELD QUALITY CONTROL AND TESTING:

A. Connection and Supervision: Make connections to panel and perform all testing under the supervision of the Manufacturer's Authorized Representative.
B. Protect fire alarm devices during construction. Replace any unprotected smoke detectors.
C. All wiring shall test free from open conductors, shorts and/or crosses between conductors, and grounded conductors.

3.08 TESTING:

A. The Manufacturer's Authorized Representative (FASSP) shall perform all testing.
B. Participate in pre-testing with subcontractors for any and all systems with interface with the Port fire alarm system.
C. Provide all materials, equipment and labor for testing.
D. System Test and Approval:
   1. Prior to final acceptance of system, the Manufacturer's Authorized Representative shall test the system per NFPA 72 requirements. Test each automatic device.

a. Test each circuit for open circuits, shorts, grounds and loop resistance. Record test results of each circuit test and include in close-out submittals.
b. Test all annunciator interfaces for proper operation.
c. All water flow devices shall be tested with actual water flow.
d. Correct any deficiencies prior to final acceptance testing. Submit written notification to the Owner that the system has been pre-tested all deficiencies corrected.

2. In presence of the Authority Having Jurisdiction, Owner's Representative and the Manufacturer's Authorized Representative shall perform acceptance testing in accordance with NFPA 72. Test each automatic device in accordance with NFPA 72.
3. After being signed by the Authority Having Jurisdiction, submit a copy of test results to the Engineer, Owner, and Owner's insurance carrier, and the Authority Having Jurisdiction. Provide a copy of the inspection record at the fire alarm control panel.

E. TRAINING
1. Provide operation and maintenance training for Port personnel.
2. Conduct a minimum of three maintenance training sessions (one for each shift). Maintenance training sessions shall include a walk-through of the completed facilities identifying the location, address, and means of access to every device monitored by the fire alarm system.
3. Conduct training sessions for two operator levels.
   a. Operator training. Provide a minimum of three refresher and system update training sessions (one for each shift) of on-the-job training.
   b. Supervisor training. Provide a system update training session for supervisory functions.
4. Training sessions shall be given by a fully qualified, trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.

3.09 MAINTENANCE:

A. The equipment supplier shall maintain a local service organization which is available to perform testing, inspection, repair and maintenance service on the system.

3.10 SPARE PARTS:

A. Keys and locks for all equipment shall be identical where possible. Not less than 6 keys for each type required shall be provided. Keys shall be identified by an appropriate number stamped on the key or on a metal tag attached thereto. If required, a key numbering chart shall be provided in each operations and maintenance manual furnished.

END OF SECTION 283100

SECTION 31 08 13 – STATIC PILE LOAD TESTING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers the requirements for load testing of piles under static axial compression, and static lateral modes of loading.

B. The number of static pile load tests for each mode of loading shall be as defined in the applicable Foundation Piling Section.

C. The Design Capacity, Maximum Anticipated Test Load, and Ultimate Capacity for each mode of loading shall be as defined in the applicable Foundation Piling Section.

D. Pile load testing shall be performed from a working elevation within 1 foot of the anticipated final design pile cutoff elevation.

1.02 REFERENCE STANDARDS:

A. General:

1. Standards listed by reference, including revisions by issuing authority, form a part of this Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
2. Where specifications and reference documents conflict, the specification shall govern.
3. Unless otherwise noted, the latest revision of the following reference standards shall apply to this Section.

B. Applicable Standards:

1. ASTM International (ASTM):
   a. D1143/D1143M – Test Methods for Deep Foundations Under Static Axial Compressive Load.
   b. D3966/D3966M – Test Methods for Deep Foundations Under Lateral Load.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Design and Pre-Construction Submittals:

1. Provide the following submittals two weeks prior to commencing load testing:
   a. Details of load test arrangements (plan, location, and elevation).
   b. Drawings and calculations for member reaction frame beams, connections, stiffeners and piles; signed and sealed by Subcontractor's Professional Engineer.
   c. Electrical load cell calibration curves.
   d. Hydraulic jack calibration curves.
   e. Methods for performing load test.
   f. Embedment length of reaction piles with calculations proving adequate capacity for load test requirements.
   g. Reaction pile pretension sequence (if applicable).
   h. Dial gauges; minimum 4 around load test pile head for axial loading, and minimum 2 around load test pile head for lateral loading.
   i. Swivel plate.
   j. Thermometer.
   k. Piano wire/mirror/engineer’s scale setup.
      (a) Portable gas generator, fuel, and operator for continuous power to equipment (if required for electronic readout).

l. Weatherized enclosure for protection of all materials and equipment from the elements, if required.
m. Sandbags and/or grading to divert water, if required.
n. Schedule of load testing.

2. The calibration testing shall have been performed by an independent testing laboratory and tests shall have been performed within 6 months of the date submitted. Contractor will approve or reject the calibration data within five working days after receipt of the data. Testing cannot commence until Contractor has approved the calibration data.

C. Construction and Closeout Submittals:
1. Submit test pile installation records within 24 hours of the completion of installation, including all information required for production piles.
2. Submit load test data within 48 hours of the completion of static pile load testing operations; consisting of dial gauge readings for all test and reaction piles, scale/mirror/piano wire readings, survey data, hydraulic jack pressure data and load cell data.

PART 2 - PRODUCTS

2.01 TEST PILES:

A. Test piles and reaction piles shall be installed in accordance with procedures and material requirements for production piles.
B. The diameter/width and depth of load test piles shall be equal to the proposed production pile dimensions, unless noted otherwise by the Contractor.

2.02 EQUIPMENT:

A. All equipment necessary for the pile load test; such as load cell, hydraulic jacks, dial gauges, swivel plate, thermometer, piano wire, mirror, engineer's scale, surveyor's level, etc., shall be furnished and operated by Subcontractor. The equipment shall conform to the requirements of ASTM D1143/D1143M, and D3966/3966M for the respective mode(s) of loading.
B. The apparatus for applying and measuring axial loads shall be capable of safely applying at least 120% of the maximum anticipated test load.
C. The apparatus for applying and measuring lateral loads shall be capable of safely applying at least 125% of the maximum anticipated test load.
D. Provide adequate back-up equipment to complete all load testing operations.
E. Loads shall be applied to the pile accurately and concentrically by means of certified, calibrated hydraulic jacks, pressure regulating devices and tanks, hand jacks, or other approved equipment so that there will be a constant load maintained under increasing pile deflection.
F. Using hydraulic jack pressure gauges or transducers as sole means to control applied loads in lieu of an in-line load cell will not be permitted.
G. Ground line for the load testing operations shall be established as the elevation which coincides to the appropriate production pile cutoff elevation.
H. The equipment for lateral load testing shall be capable of supporting and applying the test load within 3 inches of the ground line.

2.03 REACTION FRAME:

A. Subcontractor shall provide all necessary equipment, materials and labor to provide and install the test pile reaction systems. The reaction frames and all associated members shall be designed by Subcontractor's Engineer and shall be capable of safely loading the pile to three (3) times the Design Load or the Maximum Anticipated Test Load (whichever is greater).

B. Structures and reaction beams for the load tests shall be constructed in accordance with specifications and approved shop drawings.
C. Test arrangement shall be designed so that loads are applied to the pile accurately and concentrically.
D. Load test reaction pile layout shall consist of the following:
   1. Piles shall be uniformly and evenly spaced with respect to both axes of the test pile centerlines. The number of required reaction piles shall be determined based upon specified ultimate test pile and allowable reaction pile capacity values, and as required by Subcontractor's Professional Engineer. Reaction piles may need to be installed deeper than test piles to provide sufficient reaction capacity to the applied test pile load.
   2. Placement of all reaction piles in a single line will not be permitted for axial loading. Subcontractor shall use a minimum of four reaction piles for the axial loading modes, and two reaction piles for the lateral loading mode.
   3. If Subcontractor plans to pretension the reaction piles, detailed procedures of the pretension loading sequence shall be submitted to the Contractor.
   4. Satisfy minimum spacing specified in ASTM D1143/1143M, and D3966/3966M for the applicable mode of loading as required to avoid overlapping of pile stresses.
   5. Height of test and reaction piles above ground surface shall be minimized for axial loading modes to limit unsupported height of piles under axial loading. Soil confinement around pile at time of testing shall coincide with final grade for pile cap base, taking into account proposed pile cutoff elevations.
E. Alternate methods of dead weight reaction system consisting of a tank to be filled with water or dead weight reaction system may be used for axial compression mode, as designed by Subcontractor's Professional Engineer, and as approved by Contractor.
F. All reaction components, including but not limited to, steel reinforcement, lock off nuts, welds, wide flanges, and other load test system equipment shall be designed, fabricated, and constructed by Subcontractor to adequately support or maintain ultimate load test capacities as specified.
G. Design the structures and test apparatus to safely carry the test loads during all stages of loading and unloading in a manner that will adequately support the imposed loads and prevent movement perpendicular to the direction of loading. The load platform shall be supported by piles, cribbing, or other approved means designed so as to prevent excessive deflection and to preclude differential movement, tilting, or eccentric loading.
H. Where specified, shown on Contract drawings, or as required by Subcontractor's Professional Engineer, brace the jack/load cell assembly to prevent lateral movement of the pile(s) and buckling or loss of jack/load cell assembly. Limit height of exposure at test pile to minimize movement perpendicular to the direction of loading. The system of bracing shall not restrain deflection of the pile due to imposed test load.

2.04 PILE MOVEMENT MONITORING EQUIPMENT

A. Subcontractor shall install reference beams and dial gauges as the primary means to measure test pile movement. Dial gauges shall have a precision of one thousandth (0.001) of an inch and shall provide for a travel of three (3) inches.
B. A minimum of four dial gauges shall be installed at 90-degree intervals around the test piles subjected to axial loading.
C. Two (2) dial gauges shall be installed on the lateral load test pile; one horizontally at or near the ground line (coinciding with the point of load application), and one horizontally at 12 inches above the first.
D. A minimum of one dial gauge shall be installed at each reaction pile.

E. Reference beams may be made from wood, angle steel, or pipe that is stiff in consistency. Only one location of each reference beam shall be fixed, with all other portions being surface supported and free floating to permit elongation or contraction of reference beams without affecting dial readings.
F. Subcontractor shall install a scale/mirror/piano wire setup supported with an additional independent set of reference beams, isolated from the main reference beams, as a secondary means to measure test pile movement. In lieu of the scale/mirror/piano wire setup, Subcontractor may elect to utilize a surveyor's level instrument tied to an independent reference scale approved by the Contractor as the secondary means of measuring test pile movement.

PART 3 - EXECUTION

3.01 PILE LOAD TEST:

A. For all pile types, test pile loading shall not commence until a minimum of 7 days after completion of test pile installation activities.
B. In addition to the requirement listed above, load testing operations for concrete-filled or grouted pile types shall not commence until the test pile concrete and/or grout achieves the required design strength, as specified in the applicable Foundation Piling Section. Perform grout compression tests on the day that the piles are load tested. Results of laboratory cube breaks (f_c' and E) shall be submitted to Contractor prior to commencement of load testing program.
C. Perform static pile load tests at the location shown on the drawings, or where approved by Contractor. The load testing shall be performed prior to the start of production pile installation. The scheduling of load testing shall be as approved by Contractor.
D. Unless otherwise specified in the applicable Foundation Piling Section, the Subcontractor shall perform load testing at non-production pile locations to be abandoned upon completion of the load test program.
E. Subcontractor shall provide qualified personnel to set up and operate all equipment required for the load testing.
F. For lateral load testing, the hydraulic jack shall be fully supported by a dug out cradle in the ground surface or by other bracing to prevent the jack from slipping out during loading. The cradle shall be sufficient to allow placement of the saddle, bearing plates, hydraulic jack, and dial gauges. The jack shall be positioned with its ram moving horizontally at a location somewhere between the ground line and a point 3 inches above or below the ground line.
G. Protect benchmarks, reference marks, test piles, reference beams, dial gauges, jacks, compensators and pressure tanks with canopy, canvas or other protective system from the sun. In addition, provide a portable shelter to shield the survey level instrument from sun, rain, and wind, and provide necessary lighting to conduct the load test during the hours of darkness. Provisions shall also be made to prevent inundation of the load test area as a result of precipitation, runoff, etc. Mound soil, provide sandbags or other grading around edges of the test pile location and divert all water encountered.
H. The load test shall only be performed in the presence of Contractor.
I. Provide personnel to operate load test equipment throughout all required tests.
J. Loading Sequence:
    1. Axial compression load tests shall be performed in accordance with the procedures outlined in Part 8.1.2 of ASTM D1143, Procedure A – Quick Test (with the following modifications):

a. Except as modified herein, the static axial compression pile load testing shall be performed in general accordance with the latest revision of ASTM D1143/1143M. In the event of conflicting provisions between ASTM D1143/1143M, the provisions of this Section shall govern.
b. Loading sequence shall be applied in increments of 5% of the maximum anticipated test load. Add load increments until reaching a failure load but do not exceed the safe structural capacity of the pile or loading apparatus. During each load interval, keep the load constant for a time interval of 10 minutes, using the same time interval for all loading increments throughout the test. The time interval for the maximum test load shall be held for 60 minutes to assess creep behavior.
c. Remove the load in five equal decrements, keeping the load constant for a time interval of 10 minutes, using the same time interval for all unloading decrements. The time interval for the final zero load shall be held for 60 minutes to assess rebound behavior.
d. Record test readings for 10-minute load increments at 1, 5 and 10 minutes. Record test readings for the 60-minute load hold at 1, 5, 10, 15, 20, 40, and 60 minutes. Record test readings for 10-minute load decrements at 1, 5, and 10 minutes.
e. If pile failure occurs prior to reaching the maximum anticipated test load, continue jacking the pile until the total axial movement equals 15% of the pile butt diameter or width.
f. If excessive tilting of the pile reaction system is observed, cease testing and remove the load. Re-align system and re-start testing.

2. Lateral load tests shall be performed in accordance with the procedures outlined in Section 8.1.2 of ASTM D3966/3966M, Procedure A – Standard Loading (with the following modifications):
   a. Except as modified herein, the static lateral pile load testing shall be performed in general accordance with the latest revision of ASTM D3966/3966M. In the event of conflicting provisions between ASTM D3966/3966M the provisions of this Section shall govern.
   b. Loading sequence shall be applied in the following increments (relative to the maximum anticipated test load): increments at 12.5% and 25% of maximum anticipated test load (to be held for 10 minutes), increment at 37.5% of maximum anticipated test load (to be held for 15 minutes), and increments at 50%, 62.5%, 75%, 85%, 90% and 95% of maximum anticipated test load (to be held for 20 minutes each). Add load increments until reaching a failure load but do not exceed the safe structural capacity of the pile or loading apparatus. During each load interval, keep the load constant for the entire specified time interval. The time interval for the maximum test load shall be held for 60 minutes to assess creep behavior.
   c. Remove the load in four equal decrements, keeping the load constant for a time interval of 10 minutes, using the same time interval for all unloading decrements. The time interval for the final zero load shall be held for 60 minutes to assess rebound behavior.
   d. Record test readings for 10-minute load increments at 1, 5 and 10 minutes. Record test readings for 15-minute load increment at 1, 5, 10, and 15 minutes. Record test readings for 20-minute load increments at 1, 10 and 20 minutes. Record test readings for the 60-minute load hold at 1, 5, 10, 15, 20, 40, and 60 minutes. Record test readings for 10-minute load decrements at 1, 5, and 10 minutes.

e. If excessive pile movement (i.e. failure) occurs prior to reaching the maximum anticipated test load, continue jacking the pile until the total lateral movement equals the maximum value as defined in the applicable Foundation Piling Section.
f. If excessive tilting of the pile reaction system is observed, cease testing and remove the load.

K. Subcontractor's personnel shall perform optical survey and dial gauge readings of test and reaction piles throughout all required tests.

L. Evaluation of static pile load test data for determination of the ultimate pile capacity values and final production pile dimensions shall be in accordance with the requirements of the applicable Foundation Piling Section.

M. Cut off all non-production test and reaction piles to be abandoned to a depth below prevailing ground surface of at least 3 feet. Subcontractor, prior to abandoning piles in-place, shall determine and record the location of all test and reaction piles relative to reference marks at the site.

END OF SECTION 31 08 13

SECTION 31 08 17 – DYNAMIC PILE TESTING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section specifies requirements for dynamic testing of driven foundation piling.

B. Dynamic testing requires attaching two strain transducers and two accelerometers to the pile usually 1.5 to 3 pile diameters below the pile head during initial driving or at a convenient location during restrike testing. A cable connects the sensors on the pile with the Pile Driving Analyzer® (available from Pile Dynamics, Inc., 30725 Aurora Road, Cleveland, OH 44139, USA; www.pile.com/pdi; email: sales@pile.com; phone: +1 216-831-6131; fax +1 216-831-0916) or equivalent, located at ground level a safe distance away from the pile.

C. Dynamic testing shall be performed on all indicator piles as indicated to assess the performance of the hammer, confirm the set, capacity, allowable driving stresses and observed driving resistance with depth of the piles. Dynamic testing of indicator piles shall be performed at locations as designated by Contractor during the entire length of initial driving and during restrike driving.

D. A percentage of additional production piles shall have dynamic testing performed throughout production driving at locations designated by the Contractor. This percentage shall be as specified in the applicable Foundation Piling Section.

E. The minimum duration between initial driving and restrike driving shall be as specified in the applicable Foundation Piling Section.

F. Dynamic testing shall be performed to verify that piling is being driven sufficiently to achieve their required design compression and design tension capacities with the specified safety factor value(s) as summarized in the applicable Foundation Piling Section.

1.02 REFERENCE STANDARDS:

A. Applicable Standards:

1. ASTM International (ASTM):
   a. D4945 - Standard Test Method for High-Strain Dynamic Testing of Deep Foundations.
2. Hannigan, P.J. et al, 2006. Workshop Manual on Design and Construction of Driven Pile Foundations, U.S. Department of Transportation, Federal Highway Administration, Report No. FHWA-HI-96-033, Washington, D.C., pp. 11-3 to 11-9.
3. American Association of State and Highway Transportation Officials (AASHTO):
   a. AASHTO LRFD Bridge Design Specifications, Sixth Edition, 2012.

1.03 SUBMITTALS:

A. Bid Submittals:

1. Experience and qualifications of Dynamic Testing Consultant.

B. Pre-Construction Submittals:

1. Pile Driving Equipment Data:
   a. Submit detailed information regarding make and model of pile hammer and driving equipment two weeks prior to commencement of indicator pile driving activities. Submit details of driving helmets, cap-blocks, pile cushions, follower, and driving heads. Include weight, dimensions, stiffness and coefficient of restitution of cap block assembly (helmet, hammer cushion materials, and driving head); dimensions, stiffness, coefficient of restitution and type of material(s) of cushion (pile cushion).
   b. Do not commence pile driving activities until complete pile hammer and driving equipment submittals have been received and accepted by Contractor.
2. Pile driving layout and sequence plan:

a. Show the location, identification, order and orientation in which piles will be driven, and describe how the sequence will minimize piles from being displaced laterally when driving subsequent piles.
b. Unless otherwise noted in the applicable Piling Section, it is intended that all indicator piles be installed at final production pile locations, uniformly distributed across the site, driven in a sequential manner to minimize their impact to production pile installation at the Site and so as to permit ease of access to subsequent production piles.
c. The location of the indicator piles is subject to review and approval by the Contractor.

C. Construction Submittals:
1. New or modified pile driving system or installation procedures, as applicable.
2. Dynamic Testing Consultant shall provide preliminary dynamic testing reports and data files within 24-hours of completion of each test.
3. Dynamic Testing Consultant shall provide summary report of all finalized data from all piles tested prior to final payment.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. Dynamic monitoring shall be performed using a Pile Driving Analyzer. All equipment necessary for the dynamic monitoring such as sensors, cables, etc., shall be furnished by Dynamic Testing Consultant. The equipment shall conform to the requirements of ASTM D4945.
B. Provide power capable of operating an electric drill to install sensor attachment holes in the test piles. Provide a 12 to 24 volt D.C. power source (e.g. car battery) for operating the Pile Driving Analyzer.

PART 3 - EXECUTION

3.01 CONSTRUCTION ACCESS:

A. Prior to lifting the pile to be dynamically tested, provide a minimum of 3 feet of clear access to 180 degree opposite faces of the pile for pile preparation. Dynamic Testing Consultant or Piling Subcontractor's personnel shall then drill and prepare holes in the pile for attachment of sensors.
B. Dynamic Testing Consultant or Piling Subcontractor’s personnel will attach the sensors to the pile prior to initial driving. Driving shall then continue using routine pile installation procedures. When the sensors approach the ground surface, water surface, or a pile template, driving shall be halted to remove the sensors from the pile to prevent damage to the sensors. If additional driving is required, the pile shall be spliced and the sensors shall be reattached to the next pile segment prior to continuing driving.

3.02 TESTING PROCEDURES:

A. Preconstruction Wave Equation Analyses:
1. Contractor will use Pile Driving Equipment Data to perform a wave equation analysis. The wave equation analysis performed by the Contractor will be used to assess the ability of the Piling Subcontractor’s proposed driving system to install the pile to the required capacity and desired penetration depth within the allowable driving stresses.

2. Approval of the proposed driving system by Contractor shall be based upon the wave equation analysis indicating that the proposed driving system can develop the ultimate pile capacities as identified by the Contractor at an acceptable driving resistance not greater than 10 to 20 blows per inch within allowable driving stress limits. Contractor will propose a preliminary driving criterion based on this wave equation analysis and anticipated soil strength changes after driving, subject to further dynamic testing results.
3. A new pile driving system, modifications to existing system, or new pile installation procedures shall be proposed by Piling Subcontractor if the pile installation stresses predicted by wave equation analysis or calculated by the Pile Driving Analyzer exceed the following maximum values:
   a. Definitions:
      (1) F_y: Yield stress of section
      (2) f'_c: Compressive strength of concrete section
      (3) ϕ: LRFD resistance factor (AASHTO, 2012).
   b. Steel Pile Sections:
      (1) Compressive Stress: 0.9 x F_y
      (2) Tensile Stress: 0.9 x F_y
   c. LRFD Driving Stresses (AASHTO, 2012):
      (1) Concrete Piles, ϕ = 1.00 (Article 5.5.4.2.1)
      (2) Steel Piles, ϕ = 1.00 (Article 6.5.4.2)

B. Dynamic Monitoring:
1. Dynamic monitoring shall be performed during driving in accordance with ASTM D4945, and as directed by Contractor. Dynamic testing data shall be recorded on every blow throughout monitoring for all piles monitored at the site.
2. An experienced civil/structural/geotechnical engineer provided by Dynamic Testing Consultant shall operate the Pile Driving Analyzer in the field and be certified at a minimum level of BASIC (second of four levels) on the PDI/PDCA Dynamic Measurement and Analysis Proficiency Test or the Foundation QA High Strain Dynamic Pile testing Examination to perform all monitoring and reporting activities.
3. Dynamic Testing Consultant shall take measures to ensure that the location of strain gage placement does not impact the accuracy of the ultimate compression capacity of the piling per Pile Driving Analyzer and CAPWAP analyses (check proportionality values).
4. Installation of indicator piles is typical of normal pile installation except Dynamic Testing Consultant may frequently stop driving to request changes in the hammer fuel setting, recommend changes to cushion material and/or thicknesses, or to check the PDA gauges and equipment. If requested, provide Dynamic Testing Consultant access to the head of the pile to check the gauge and cable attachments, change gauges, or perform similar work. Provide a qualified member of the pile driving crew to assist the Dynamic Testing Consultant with such work as directed.
5. Cushions and hammer fuel settings: Contractor may request combinations of hammer cushions and thicknesses, and hammer fuel settings be investigated during the testing. Piling Subcontractor shall cooperate with Contractor by installing the indicator piles using combinations of cushion material and thicknesses, and hammer fuel settings selected by Contractor. Change cushions, or change hammer fuel settings when requested by Contractor.

3.03 DYNAMIC TESTING REPORTS

A. The Dynamic Testing Consultant shall prepare a written report of the dynamic testing operations. This report shall include a discussion of the pile capacity results obtained from the dynamic testing. The report shall also discuss hammer and driving system performance, driving stress levels, and pile integrity. The report data shall be provided to Contractor for review immediately upon completion of each dynamic pile testing operation, and prior to installation of further production piling. Dynamic Testing Consultant shall provide Contractor with electronic copies of the W01/X01 data files generated during the dynamic testing immediately upon completion of each dynamic pile testing operation.

B. CAPWAP analyses of the dynamic pile testing data shall be performed on data obtained from the end of initial driving and the beginning of restrike as specified in the applicable Foundation Piling Section.

C. If a portion of the remaining production piles are to be monitored with dynamic pile testing, they shall also have CAPWAP analysis performed as selected by the Contractor. The required percentage shall be as specified in the applicable Foundation Piling Section.

D. Contractor may request additional CAPWAP analyses at selected pile penetration depths to investigate potential alternate bearing layers or time dependent soil strength changes.

E. Contractor may request that Dynamic Testing Consultant perform a refined wave equation analysis or analyses based upon the variations in the subsurface conditions and/or drive system performance observed during dynamic pile testing.

F. Contractor will perform evaluation of all dynamic testing reports for the development of appropriate driving resistance criteria for the project.

END OF SECTION

SECTION 31 20 01 – SITE PREPARATION AND EARTHWORK - FUEL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Preparing and grading subgrades for slabs on grade, walks, and pavements.
   2. Excavating and backfilling for buildings and structures.
   3. Excavating and backfilling for underground utilities and appurtenances.
   4. Crushed aggregate base.
   5. Crushed aggregate surfacing.
   6. Riprap.
   7. Pipe bedding materials.

1.03 RELATED REQUIREMENTS:

1. Section 01 57 13 – Temporary Erosion, Sediment, and Pollution Control
2. Section 02 41 19 – Selective Demolition
3. Section 02 61 00 – Removal and Disposal of Contaminated Soils
4. Section 31 23 19 – Dewatering
5. Section 32 12 00 – Asphalt Concrete Paving
6. Section 32 16 13 – Concrete Curbs
7. Section 32 16 15 – Concrete Sidewalk
8. Section 32 92 00 – Seeding
9. Section 33 11 16 – Water Distribution Piping
10. Section 33 31 00 – Sanitary Sewer
11. Section 33 41 00 – Storm Drainage System

1.04 REFERENCE STANDARDS:

A. Name of Referenced Standard:
   1. ASTM International (ASTM):
      a. ASTM C33 - Standard Specification for Concrete Aggregates.
      b. ASTM C144 - Aggregate for Masonry Mortar.
      c. ASTM C150 - Portland Cement.
      d. ASTM C618 - Fly Ash and Raw and Calcined Natural Pozzolans for Use in Portland Cement Concrete.
      e. ASTM D1241 - Materials for Soil-Aggregate Subbase, Base and Surface Courses.
      f. ASTM D1556 - Density of Soil In-Place by Sand-Cone Method.
      g. ASTM D1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. - lbf/ft.^{3}).
      h. ASTM D2487 - Standard Test Methods for Classification of Soils for Engineering Purposes.
      i. ASTM D4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      j. ASTM D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

k. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
l. ASTM D4533 - Trapezoid Tearing Strength of Geotextiles.
m. ASTM D4546 - One-Dimensional Swell/Settlement Potential of Cohesive Soils.
n. ASTM D4632 - Breaking Load and Elongation of Geotextiles (Grab Method).
o. ASTM D4751 - Test Method for Determining the Apparent Opening Size of a Geotextile.
p. ASTM D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
q. ASTM D6241 – Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
r. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil Aggregate by Nuclear Methods (Shallow Depth).
s. ASTM G57 – Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.

2. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR Part 1926 - Safety and Health Regulations for Construction.
3. State of Oregon Department of Transportation (ODOT) Standard Specifications for Construction.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.
B. Includes, but not limited to, the following:
   1. Test results from laboratory testing of proposed borrow materials.
   2. Erosion and dust control plan.
   3. Dewatering plan.
   4. Compaction equipment to be used for fill, trench backfill, and other backfill operations.
   5. Warning tape data.
   6. Riprap data.
   7. Aggregate materials data and tests:
      a. Structural fill.
      b. Conduit and fuel pipe bedding (sand).
      c. Pipe bedding.
      d. Excavation/trench stabilization material.
      e. Capillary water barrier.
      f. Crushed aggregate base.
      g. Crushed aggregate surfacing (driveway, non-driveway, and dike area).
   8. Flowable fill data.
   9. Geotextile data.
C. Where selecting an option for excavation, trenching, and shoring design from "OSHA Part 1926," which requires design by a Registered Professional Engineer, submit (for information only and not for Contractor approval) copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems approved by the Registered Professional Engineer obtained by Subcontractor.
D. Provide on-site survey and control services associated with the execution of the work including the initial establishment and maintaining temporary and permanent horizontal and vertical control monuments.
E. All survey work shall be performed by a Surveyor licensed in Oregon.

1.06 QUALITY ASSURANCE:

A. Tests of all Subcontractor-secured materials and products being submitted for approval to determine conformance with all requirements of these specifications including borrow materials (from both on- or off-site sources) proposed for use, shall be performed by an independent testing laboratory retained and compensated by the Subcontractor.

B. As materials are incorporated into the Project, on-site and off-site quality control tests will be performed during construction to determine conformance with Drawings and Specifications by an independent testing laboratory retained and compensated by the Contractor. Frequency of on-site and off-site testing is specified in Part 3.

1.07 PROJECT SITE CONDITIONS:

A. Lines and grades shall be as indicated. Contractor will furnish survey reference points as necessary to permit the Subcontractor to lay out and construct the Work properly.

B. Carefully maintain all survey reference points and replace as directed by the Contractor if disturbed or destroyed.

C. Temporary Erosion, Dust and Sediment Controls shall be in accordance with Section 01 57 13 – Temporary Erosion, Sediment, and Pollution Control.

D. Disposition of Utilities:

1. Existing underground utilities are shown on Contract Drawings using the best information available at the time of preparation. The exact location, number and limit of existing utilities are uncertain. Subcontractor shall identify, locate, and protect all underground utilities which may be affected by construction under this contract before starting excavation or other site construction activities which could damage utilities.
2. Remove or relocate only as indicated, specified, or directed.
3. Report inactive and abandoned utilities encountered in excavating and grading operations to Contractor. Remove, plug, or cap as directed by Contractor.
4. Provide a minimum 48 hours' notice to Contractor and receive written notice to proceed before interrupting any utility.

E. Elevations shown on Drawings refer to finish grade in unpaved areas and top of pavement grades in paved areas.

F. Geotechnical Information:

1. Geotechnical work has been performed for use in design of this Project and is available from the Contractor for use by Subcontractors in preparation of bids and during construction.

G. Soil contaminated with petroleum and other products may be encountered during this Project. Contaminated soil unearthed during trenching or excavation shall be handled in accordance with Section 02 61 00 – Removal and Disposal of Contaminated Soils and shall not be used as backfill material.

PART 2 - PRODUCTS

2.01 MATERIALS ENCOUNTERED:

A. Materials suitable for use in backfill and fill include material that is free of debris, roots, organic matter, and frozen matter and which is free of stone having any dimension greater than half the specified layer thickness. Materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg limit tests (ASTM D4318) and/or swell/pressure tests (ASTM D4546). For soils used below structural elements, such as footings, slabs, pavements, and mats, that portion of material passing the No. 40 sieve shall

have a liquid limit not exceeding 40 and a plasticity index not exceeding 25 when tested in accordance with D4318.

1. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material. Cohesionless materials are free-draining materials for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods, and for which generally less than 15% by dry weight of soil particles pass a No. 200 sieve.
2. Cohesive materials include silts and clays generally exclusive of sands and gravel and are materials for which impact compaction will produce a well-defined moisture-density relationship curve.

B. Materials unsuitable for use in backfill and fill include all material that contains debris, roots, organic matter, frozen matter, stone (with any dimension greater than half the layer thickness), or other materials that are determined by Contractor as too wet or otherwise unsuitable for providing a stable fill, subgrade, or foundation for structures.

C. Materials suitable for backfill of utility trenches and structures shall be as specified for backfill and fill except that no stones or particles may exceed 2 inches.

D. All materials encountered, regardless of type, character, composition and condition thereof shall be unclassified. Estimate quantity of various materials included prior to submitting Bid Form.

E. Waste material includes excess usable materials and materials unsuitable for use in the Work. Waste materials shall be disposed of as described in Section 02 41 19 – Selective Demolition.

F. Borrow materials includes the following:

1. Acceptable fill materials, granular materials, and topsoil obtained from locations arranged for by Subcontractor and required when sufficient suitable materials are not obtained from excavation and trenching.
2. Obtaining, excavating, handling, and final placement of materials.

2.02 STRUCTURAL FILL

A. Imported granular material used as structural fill shall be pit or quarry run rock, crushed rock, or crushed gravel or sand meeting the requirements of ODOT Standard Specifications Section 00330.14 – Selected Granular Backfill, 00330.15 – Selected Stone Backfill, or 00330.16 – Selected Stone Embankment. The imported granular material shall be angular, fairly well-graded between coarse and fine material, have less than 5% by weight passing the United States (U.S.) Standard Number (No.) 200 sieve, and have at least two mechanically fractured faces.

2.03 PIPE BEDDING MATERIAL:

A. Pipe Bedding Material for direct-buried conduit and buried fuel piping shall be clean, natural sand conforming to ASTM C144 (masonry aggregate) or ASTM C33 (fine concrete aggregate) with not more than 5% by weight passing the No. 200 sieve. Where used for fuel pipe bedding, resistivity tests for sand backfill shall verify the sand has an average wet resistivity greater than 10,000 ohm-cm as determined by ASTM G57.

	ASTM C33	ASTM C144
Sieve	Percent Passing	Percent Passing
3/8 inch	100	---
No. 4	95 to 100	100
No. 8	80 to 100	95 to 100

No. 16	50 to 85	70 to 100
No. 30	25 to 60	40 to 75
No. 50	10 to 30	10 to 35
No. 100	2 to 10	2 to 15
No. 200	---	0 to 5

Pipe bedding for other piping materials shall be crushed rock bedding.

B. Crushed rock for pipe bedding (other than fuel pipe and conduit) shall be crushed stone or crushed gravel conforming to ASTM C33 coarse aggregate, size No. 57, No. 67, or No. 7. For plastic pipe bedding, No. 57 shall be used for pipe diameters greater than 8 inches, No. 67 shall be used for pipe diameters between 6 and 8 inches, and No. 7 shall be used for pipe diameters smaller than 6 inches.

ASTM C33 Sieve	Size No. 57 Percent Passing	Size No. 67 Percent Passing	Size No. 7 Percent Passing
1-1/2 inch	100	---	---
1 inch	95 to 100	100	---
3/4 inch	---	90 to 100	100
1/2 inch	25 to 60	---	90 to 100
3/8 inch	---	20 to 55	40 to 70
No. 4	0 to 10	0 to 10	0 to 15
No. 8	0 to 5	0 to 5	0 to 5

C. Bedding for PVC underdrains Shall meet the specifications provided in ODOT Standard Specifications Section 0430.11 for Granular Drain Backfill Material. The drain rock should be wrapped in a geotextile fabric that meets the specifications provided in ODOT Standard Specifications Section 02320 for Geosynthetics for drainage geotextiles.

2.04 CAPILLARY WATER BARRIER

A. ASTM C33 coarse aggregate, Size 67.

2.05 CRUSHED AGGREGATE BASE:

A. Aggregate base course for driveway aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay, dirt, or other objectionable matter and reasonably free from thin and elongated pieces or dirt. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.

B. Imported granular material used as aggregate base (base rock) beneath pavements or structures should be clean, crushed rock or crushed gravel and sand that is fairly well graded between coarse and fine. The base aggregate should meet the specifications provided in ODOT Standard Specifications Section 02630.10 for Dense Graded Base Aggregate, depending upon application, with the exception that the aggregate has less than 5 percent by dry weight passing a U.S. Standard No. 200 Sieve, and at least two mechanically fractured faces. For use beneath abutment wall footings, the aggregate base should have a maximum particle size of 1.5 inches, while for use beneath pavements and sidewalks or other slabs (if needed) should have a maximum particle size of 1 inch.

	Percent by Weight Passing Square-Mesh Sieve	
Sieve	1.5" Max	1" Max
1-1/2 inch	95-100	100
1 inch	-	90-100
3/4 inch	55-75	-
1/2 inch	-	55-75
1/4 inch	35-50	40-55
No. 200	0-5	0-5

Report percent passing No. 4 and No. 10 sieves. Of the fraction passing the 1/4-inch sieve, 40-60 percent shall pass the No. 10 sieve.

2.06 SHALLOW FOUNDATION FILL

A. Shallow foundation fill shall consist of the on-site granular fill (sand) overlying the soft overbank deposits, imported structural fill, or a combination thereof.

2.07 DRIVEWAY AGGREGATE:

A. Aggregate surfacing course for driveway aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay or other objectionable matter, and reasonably free from thin and elongated pieces. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.

B. Granular material for driveway aggregate surfacing course shall conform to ASTM D1241, Type 1, Gradation B, and shall conform to the following:

ASTM D1241	Gradation B
Sieve	Percent Passing
2 inch	100
1-inch	75-95
3/8 inch	40-75
No. 4	30-60
No. 10	20-45
No. 40	15-30
No. 200	5-15

2.08 NON-DRIVEWAY AGGREGATE:

A. Aggregate for non-driveway areas shall be crushed stone or crushed gravel, free from lumps or balls of clay, dirt, or other objectionable matter and reasonably free from thin and elongated pieces. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality.

B. Aggregate shall meet the requirements of ODOT Standard Specifications Section 02630.11 for Open-Graded Aggregate.

2.09 STABILIZATION MATERIAL:

A. If imported granular material is used to create haul roads for construction traffic or is required for stabilization of the bases of excavations, the material shall consist of pit or quarry run rock or crushed rock sized between 2 and 6 inches, with less than 5 percent by dry weight passing the No. 4 sieve and with at least two mechanically fractured faces. The material shall be free of organic matter and other deleterious material. Material meeting the specifications provided in

ODOT Standard Specifications Section 00330.15 for Stone Backfill Material is acceptable for use, excepting recycled glass shall not be used.

2.10 FLOWABLE FILL FOR PIPE BEDDING:

A. Flowable fill shall be used where indicated and may be used in place of other pipe bedding materials with Engineer's approval.

B. A flowable fill design mix shall be developed by an independent testing laboratory retained and paid by Subcontractor. Mix shall consist of sand conforming to ASTM C33 or C144, fly ash conforming to ASTM C618, portland cement conforming to ASTM C150 or other materials approved by Engineer and have a 28 day compressive strength of not less than 25 psi or more than 100 psi.

2.11 BACKFILL AND FILL MATERIAL:

A. Material shall be free of roots or other organic matter, refuse, debris, ashes, cinders, frozen earth, or other unsuitable material.

B. Use suitable material sufficiently friable to provide a dense mass free of voids and capable of specified compaction.

C. Do not use material containing gravel, stones, or shale particles greater in dimension than half the depth of the layer to be compacted.

D. Moisture content shall be that required to obtain specified compaction of the soil.

E. Perform any wetting or drying of the material as required to obtain the specified density when compacted.

2.12 WARNING TAPES FOR UNDERGROUND UTILITIES:

A. For the purposes of early warning and identification of buried pipes during future trenching or excavation.

B. Tape shall be plastic, acid- and alkali-resistant polyethylene film with foil or metallic backing (detectable at 6-foot depth by locator equipment), at least 6 inches in width and 4 mils thick, of the color indicated, and continuously inscribed with at least 1-inch-high black lettering indicating type of buried line installed:

1. "BURIED JET FUEL LINE BELOW," yellow tape.
2. "BURIED ELECTRIC LINE BELOW," red tape.
3. "BURIED WATER LINE BELOW," blue tape.
4. "BURIED TELEPHONE/COMMUNICATIONS LINE BELOW," orange tape.
5. "BURIED SEWER LINE BELOW," green tape. (Use for containment drain piping.)

C. Use detectable warning tape above all nonmetallic piping. Tape shall be manufactured with protected integral wire, foil backing, or other means of enabling detection to 36-inch depths.

2.13 RIPRAP:

A. Riprap shall meet the material requirements of ODOT Standard Specifications Section 00390 for Class 50 riprap.

2.14 GEOTEXTILES:

A. Geotextile fabrics for segregation from adjacent soils shall meet the specifications provided in ODOT Standard Specifications Section 02320.20 for Geotextile Property Values.

PART 3 - EXECUTION

3.01 SITE PREPARATION:

A. Stripping:
   1. Remove topsoil from areas within limits of excavation, trenching, and borrow areas designated to receive compacted fill.
   2. Scrape areas clean of all brush, grass, weeds, roots, and other unsuitable material.
   3. Strip to a depth of approximately 6 inches or to a sufficient depth to remove excessive roots in heavy vegetation or brush and as required to segregate topsoil.
   4. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, debris, and stones larger than 2 inches in diameter.
   5. Remove waste from the Site.

3.02 EXCAVATION AND TRENCHING:

A. Sheeting and Bracing:
   1. Use when required for slope stability and where resulting slopes from excavation or trenching might endanger in-place or proposed structures or utilities.
   2. Provide materials on site prior to start of excavation. Adjust spacing and arrangement as required by conditions encountered.
   3. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved fill material.
   4. Subcontractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of the system.

B. Explosives: Blasting will not be permitted.

C. Excavation for Structures:
   1. Excavate area adequate to permit efficient erection and removal of forms.
   2. Trim to neat lines where details call for concrete to be deposited against earth.
   3. Excavate by hand in areas where space and access will not permit use of machines.
   4. Notify Contractor immediately when excavation has reached the depth indicated.
   5. If excavation bottom is soft, remove unsuitable subgrade material and restore bottom of excavation to proper elevation with approved stabilization material in areas over-excavated.
      a. Geotextile shall be placed as a barrier between native soil subgrade and stabilization material in conformance with the specifications provided in ODOT Standard Specifications Section 00350 for Geosynthetic Installation.
      b. Stabilization material shall be placed in conformance with the specifications provided in ODOT Standard Specifications Section 00331 for Subgrade Stabilization.

D. Trenching for Underground Utilities:
   1. Side Walls:
      a. Make vertical or sloped within specified trench width limits below a plane 12 inches above top of pipe.
      b. Make vertical, sloped or stepped as required for stability, above a plane 12 inches above top of pipe.
      c. Excavate without undercutting.
   2. Trench Depth:

a. Excavate to depth sufficient to provide the minimum bedding requirements for the pipe being placed.
b. Do not exceed depth indicated where conditions of bottom are satisfactory.
c. Increase depth as necessary to remove unsuitable supporting materials as directed.

3. Trench Bottom:
   a. Protect and maintain when suitable natural materials are encountered.
   b. Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
   c. If trench bottom is soft, remove unsuitable subgrade material and restore to proper subgrade with approved stabilization material.
      (1) Geotextile shall be placed as a barrier between native soil subgrade and stabilization material in conformance with the specifications provided in ODOT Standard Specifications Section 00350 for Geosynthetic Installation.
      (2) Stabilization material shall be placed in conformance with the specifications provided in ODOT Standard Specifications Section 00331 for Subgrade Stabilization.
4. Trench Width:
   a. Excavate trench to a width which will permit satisfactory jointing of the pipe and thorough tamping of bedding.
   b. Unless indicated otherwise, do not exceed following trench widths:
      (1) Below a plane 12 inches above top of pipe.

Nominal Pipe Size	Trench Width Minimum	Maximum
Less than 24 inches	Pipe OD + 1.50 ft.	Pipe OD + 2 ft.
24 inches and larger	Pipe OD + 2 ft.	Pipe OD + 3 ft.

      (2) For multiple pipe installations maintain trench widths below a plane 12 inches above the top of the largest pipe as follows:

	Trench Clearances	
Nominal Pipe Size of Outside Pipe	Minimum from Outside Pipe	Maximum from Outside Pipe
Less than 24 inches	6 inches	12 inches
24 to 60 inches	12 inches	24 inches
Larger than 60 inches	18 inches	30 inches

      (3) Above plane defined in (1) and (2), no maximum limit.
      (4) Maximum trench width limitations shall apply in all areas more than 3 ft. from manhole or structure walls.
      (5) Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods utilized.
5. Fill Areas: Perform trenching only after compacted fill has reached an elevation of not less than 1 foot above the top of the pipe.
6. Limit maximum length of open trench to 100 ft. in advance and to 100 ft. behind pipe installation.
7. Protect open trenches with movable barriers. Coordinate barrier requirements and placement with Contractor, Owner, and Port of Portland.
8. Test Pits:

a. Excavate test pits sufficiently in advance of trenching to enable adequate planning of construction procedure.
b. Locate as follows:
(1) Where unstable material is suspected that may require special protective measures.
(2) Where groundwater may require special handling methods.
(3) Where indicated or otherwise approved.
(4) Where interference or conflict with other utilities or structures could affect alignment of pipe.
c. To depth required to obtain information desired.

E. Dewatering:
1. Dewatering shall be accomplished in accordance with Section 31 23 19.
2. Remove subgrade material rendered unsuitable by excessive wetting or siltation and replace with approved stabilization material.
a. Geotextile shall be placed as a barrier between native soil subgrade and stabilization material in conformance with the specifications provided in ODOT Standard Specifications Section 00350 for Geosynthetic Installation.
b. Stabilization material shall be placed in conformance with the specifications provided in ODOT Standard Specifications Section 00331 for Subgrade Stabilization.

3.03 SUBGRADE PREPARATION:

A. General:
1. Excavate or backfill as required to construct subgrades to the elevations and grades indicated.
2. Remove all unsuitable material and replace with acceptable fill material. Perform all wetting, drying, shaping, and compacting required to prepare subgrade.

B. Subgrade for Fills: Roughen by discing or scarifying and wet or dry top 6 inches as required to bond with fill.

C. Subgrade for areas to receive aggregate base course, pavement, structures, and concrete slabs:
1. Extend subgrade the full width of the building areas and subgrade preparation plus 5 ft. in each direction and plus 2 ft in each direction for exterior concrete slab and pavement areas.
2. Scarify the top 8 inches of subgrades in excavation areas and recompact.
3. Subgrades below the upper 24 inches in fill areas shall be compacted to at least 90 percent of maximum density at optimum moisture content as determined by ASTM D1557.
4. Compact the upper 24 inches of cohesive soil subgrades to 95% of maximum density at optimum moisture content as determined by ASTM D1557.
5. Moisture content for cohesive and cohesionless materials shall not be more than 3% above or 3% below optimum during compaction. Stricter limits may be required to meet specified density.

D. Proof rolling: Exposed subgrade areas shall be proof rolled to detect localized zones of excessively wet, unstable, organic, or low bearing capacity materials. Proof roll within limits of proposed construction of footings, slabs, mats, or pavement and to extent of 10 feet beyond proposed exterior walls and stated limits, or as otherwise noted. Proof roll with loaded dump truck, loaded pan scrapper, 15 - ton light class pneumatic tired roller compactor, or equivalent. Ground contact pressure of 80 psi and average speed of 5 miles per hour shall be maintained and continue until extent of soft spots is determined with not less than one pass per unit area of

tire. Subgrades that exhibit rutting or pumping shall be over-excavated, backfilled, and compacted with suitable (granular) material.

3.04 CRUSHED AGGREGATE BASE:

A. Cold Weather Limitations:
   1. Base course construction shall be prohibited when atmospheric temperature is below 35ºF (6ºC).
   2. Do not place base course on frozen subgrade.
   3. Protect base course and subgrade in freezing weather and repair areas damaged by freezing, by reshaping, and recompacting.

B. Placement and Compaction:
   1. Place material without segregation of sizes and spread from spreader boxes or moving vehicles equipped to spread material in layers of uniform thickness.
   2. Compact in layers no less than 3 inches nor greater than 7 inches thick.
   3. Roll to specified compaction requirements throughout full depth of layer with tamping rollers, power rollers, rubber-tired rollers, or combination.
   4. For cohesionless materials, place in 12-inch maximum lifts (uncompacted depth). Obtain compaction by use of approved vibratory rollers and other equipment during the placement and grading of layers.
   5. Shape and smooth by blading and rolling with power roller or rubber-tired roller or both.
   6. Hand-tamp in places not accessible to rolling equipment.
   7. Aerate by blade graders, harrows, or other approved equipment when mixture is moistened by rain.

C. Degree of Compaction:
   1. Base compaction on weight per cubic foot of material passing 3/4-inch sieve and compact to at least 95% maximum density as determined by ASTM D1557 at optimum moisture.
   2. Determine and control compaction in accordance with ASTM D1557.

D. Smoothness Test:
   1. Surface shall show no deviation in excess of 3/8 inch in any 10 ft. when tested with a 10-ft. straightedge applied parallel with and at right angles to the centerlines of the paved area.
   2. Correct any deviation in excess of this amount by loosening, adding or removing material, reshaping, watering, and compacting as requested by Contractor.

E. Maintain finished base course in a condition satisfactory to Contractor until pavement is placed upon it.

3.05 FILL AND BACKFILL:

A. General Fill and Backfill:
   1. Construct to the depths, contours, and elevations indicated and as specified, using suitable approved material from excavation and borrow areas.
      a. Place material in loose lifts not exceeding 8 inches.
      b. Place only on subgrades approved by Contractor.
      c. Do not place snow, ice, or frozen earth in fill and do not place fill on a frozen surface.
      d. Remove all debris from excavation prior to placement.
      e. Compact cohesive and cohesionless soil to 95% of maximum density at optimum moisture content as determined by ASTM D1557.
      f. Moisture content shall not be more than 3% above or 3% below optimum during compaction. Stricter limits may be required to meet specified density. Obtain

compaction by the controlled movement of approved compaction equipment during the placing and grading of layers.

B. Backfilling: Backfill for structures and trenches shall be as specified for general fill and backfill with the following additional provisions.
   1. Structures:
      a. Backfill only after concrete has attained 70% design strength.
      b. Backfill adjacent to structures only after a significant portion of the structure has been built to resist the imposed load.
      c. Perform backfilling simultaneously on all sides of structures.
      d. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 10 ft. of any wall shall not exceed 20,000 lbs. gross weight.
      e. Material above a 45-degree plane intersecting the footing shall not include rock fragments incapable of passing a 2-inch screen, and no shale whether disintegrated or not.
   2. Trenches: Backfill for trenches shall be as specified for general fill and backfill and with the following additional provisions:
      a. Complete promptly upon completion of pipe embedment and approval to proceed.
      b. Use hand methods to a plane 12 inches above top of pipe.
      c. Mechanical methods shall be acceptable where hand backfill is not required.
      d. Compact backfill in lifts not exceeding 8 inches of loose material.
      e. Until compacted depth over utility exceeds 3 ft., do not drop fill material over 5 ft.

C. Pipe Bedding Material:
   1. Place pipe bedding as indicated using bedding material specified.
   2. Place pipe bedding material as follows:
      a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
      b. Add second layer simultaneously to both sides of the pipe with care to avoid displacement.
      c. Complete promptly after placement of pipe.
   3. Compact Pipe Bedding Material as follows:
      a. In lifts not exceeding 12 inches of loose material.
      b. Rod, spade, or use pneumatic or vibratory equipment (choose method that will not damage exterior coating of steel pipe).
         (1) As required to obtain not less than 95% of maximum density as determined by ASTM D1557 .
         (2) Throughout depth of embedment.

3.06 SITE GRADING, SURFACE TOLERANCES AND TOPSOILING:

A. Excavate, fill, compact fill, and rough grade to bring Project area to subgrades as follows:
   1. For surfaced areas; to underside of respective surfacing or base course.
   2. For seeded and landscaped areas; to a minimum of 4 inches below finished grade.

B. Finish Grading and Surface Tolerances:
   1. Grade and compact all areas within the Project area, including excavated and filled sections and adjacent transition areas, reasonably smooth, and free from irregular surface changes.
   2. Degree of finish shall be that ordinarily obtained from blade grader except as otherwise specified.

3. Finished subgrades which receive pavement shall not be more than 0.04 ft. above or below subgrades indicated.
4. Finished grades in unpaved areas shall not be more than 0.10 ft. above or below those indicated.
5. Test all areas to receive pavement with 10-foot straightedge applied parallel and perpendicular to centerline. Deviation shall not exceed 0.04 ft.
6. Finish all ditches and swales to drain readily.
7. Provide rounding at top and bottom of banks and at other breaks in grade.
8. Material: Use the most suitable material obtained from excavation and stripping operations and borrow when required.
9. Clear areas free of vegetation, rock, and other materials which would interfere with grading.

3.07 WASTE MATERIALS:

A. Remove unsuitable materials from Work area as excavated.
B. Demolished or excavated materials such as asphalt, concrete, and others which are unsuitable for reuse in the Project (as determined by Contractor) shall become property of Subcontractor and be disposed of off-site at locations arranged for and paid for by Subcontractor.

3.08 TOPSOILING:

A. Material: Use the most suitable material obtained from excavation and stripping operations and borrow when required.
B. Placement:
   1. Clear areas free of all stones or other objects larger than 2 inches in least dimension, all roots, brush, wire, grading stakes, and other objectionable materials which would interfere with grading and tillage operations.
   2. Bond topsoil to the subgrade by scarifying the subgrade to a depth of 2 inches.
   3. Spread topsoil to the minimum depth indicated or 4 inches where grading operations have left less than 4 inches of topsoil in place.
   4. Grade topsoil to bring areas to grades as indicated and to ensure that all surfaces are left in an even and properly compacted condition and to prevent ponding of water in depressions.

3.09 GEOTEXTILES:

A. Install in accordance with manufacturer's recommendations on approved subgrades and as specified herein.
B. Supply material in widths required to minimize seams and laps.
C. Secure material in place on slopes, trench walls and other surfaces where needed to prevent displacement by wind or construction operations. Use pins recommended or supplied by fabric manufacturer.
D. Subgrades shall be free of sharp objects or debris.
E. Fabric used for segregation and drainage such as in trenches and under stabilization material shall have a minimum of 6 inches of overlap. Fabric used for reinforcement under pavement shall have a minimum of 18 inches of overlap unless otherwise recommended by the fabric manufacturer.

3.10 ON-SITE TESTING:

A. The Contractor will retain and compensate an independent testing lab to perform the following tests. The Subcontractor shall provide testing laboratory access to work which is to be tested

and include in his bid all costs for delays associated with the performance of the described testing by Contractor's testing lab. The Subcontractor shall notify the Contractor no less than 24 hours before work is expected to be ready for testing.

B. The method of in-place compaction testing including density and moisture content will be as follows:
   1. Density: ASTM D6938 (Nuclear Density) and ASTM D1556 (Sand Cone Density).
   2. Moisture Content: ASTM D6938 (Nuclear Moisture).

C. A representative frequency of in-place compaction tests including density and moisture content shall be as follows:
   1. At least one test for every 100 yds^3 of backfill placed in trenches.
   2. At least one test for every 500 $ft.^2$ where subgrade preparation for paved areas and aggregate driveway areas is being performed.
   3. At least one test for every 200 $ft.^2$ but not less than one test per lift in fill around structures.
   4. At least one test when Contractor suspects the moisture content or effectiveness of compaction is not acceptable.
   5. In-place density may be tested by ASTM D6938 (nuclear) or by ASTM D1556 (sand cone), but at least one ASTM D1556 test shall be performed for every ten ASTM D6938 tests or portion thereof.

D. Fill failing to meet required densities or moisture contents shall be scarified and recompacted as necessary to achieve specified results.

E. Removal of in-place material and replacement with approved new material will be required if scarifying and re-compaction do not produce the required densities.

F. Perform at least one ASTM D2487 (Classification of Soil) and one ASTM D698 (Compaction) test on soil used in fill or backfill operations during construction.
   1. Each sample shall be taken from trenches or other excavations as directed by Contractor and should be generally representative of distinguishably differing materials encountered and used for backfill or fill.
   2. Perform one set of tests at the beginning of excavation and one additional set of tests when material properties vary (wetter, dryer, more granular, or other conditions) from the material initially tested.
   3. Additional tests shall be performed when directed by Contractor.

G. Perform at least one ASTM D1557 (Compaction) test for every 2,500 yds^3 of material placed.

3.11 RIPRAP:

A. Foundation Preparation:
   1. Trim and dress areas requiring riprap to conform with lines as indicated within an allowable tolerance of +3 inches from the theoretical slope lines and grades.
   2. Fill areas below tolerance limit with suitable material and compact.
   3. Do not place riprap until the base has been accepted.

B. Placement:
   1. Place stones to full course thickness in one operation and in a manner to avoid displacing the underlying material.
   2. Place stone on the prepared base to produce a reasonably well-graded mass of stone in close contact and with a minimum of voids.
   3. Place within a tolerance of +3 inches from the theoretical slope lines and grades.
   4. Maintain the riprap protection until accepted; replace any material displaced.

3.12 MAINTENANCE AND CLEANUP:

A. Protect newly graded areas from actions of the elements.

B. Settling or erosion occurring shall be filled and repaired and grades re-established to the required elevations and slopes.

C. Keep paved areas clean. Promptly remove rock or dirt dropped upon paved surfaces by sweeping, washing, or other methods acceptable to Contractor.

END OF SECTION 31 20 01

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes dewatering required for trenching, excavation, and construction of underground utilities.

B. Sand, silt, and soils expected to be encountered in this area are sensitive to groundwater seepage and pore pressures.

C. Excavation and filling of sumps and ditches in the trench or excavation bottoms for dewatering purposes shall be considered incidental to the work.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

1.3 REFERENCES

A. DEQ: Oregon Department of Environmental Quality

B. OR UIC: Oregon Underground Injection Control

C. National Pollutant Discharge Elimination System (NPDES) General Permit 1200-CA dated September 15, 2022.

1.4 PERMITS

A. The Port is the administrator of the NPDES General Permit 1200-CA for the Discharge of Construction Site Runoff to Public Waters on projects performed by or for the Port on Port property. A copy of the permit and its regulations is on file at the Port's Engineering offices. The Port is mandated by law to comply with this permit. Contractor and Subcontractor shall comply with the requirements of the permit.

1.5 SUBMITTALS

A. At least 2 weeks prior to beginning dewatering work, submit a dewatering plan to the Port for review.
   1. The dewatering plan shall describe the method, details, installation, and operation of the proposed system. The plan shall demonstrate the control of groundwater to improve stability of the walls and bottom of the excavations. Include the following:

a. A site map depicting the work areas where dewatering systems will be installed or locations where dewatering will be performed and location where produced water will be discharged.
b. A schedule that sets forth anticipated dates of dewatering activities during construction and dates for initial effluent sampling (to be performed by the Port) for each new anticipated location.
c. Description and location(s) of structures, devices, and other means and methods that will be installed or used to treat/control turbidity, suspended solids, and other pollutants (if any), prior to the discharge of produced waters.

B. Submit an operation and maintenance plan if an active treatment system such as electro-coagulation, flocculation, or filtration is employed for sediment or other pollutant removal. This plan, at a minimum, shall include system schematic, location of system, location of inlet, location of discharge, discharge dispersion device design, and a sampling plan and the sample frequency. Do not operate the treatment system until the plan has been approved by the Port and DEQ. Operate and maintain the system in accordance with manufacturer's requirements.

C. During the course of dewatering, submit the following:
1. Copies of inspection logs.
2. If Subcontractor elects to conduct independent sampling, provide the Port with copies of all water quality sampling and analysis reports performed or completed.
3. Any changes to the output capacity of dewatering activities.

D. If dewatering wells are installed, submit a copy of the well start card and well report as submitted to the State of Oregon Water Resource Department.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 DISCHARGE INSPECTIONS

A. At least daily, inspect all locations where water from dewatering activities is being discharged to determine the water's cleanliness and assure that systems are functioning properly. If contamination is suspected, stop dewatering activities immediately and notify the Port. Evidence of contamination includes oil sheen on the water surface, discoloration of soil or water, odor of solvents or fuel, or any knowledge of pollutants. Submit written logs documenting these inspections.

3.2 UNDERGROUND INJECTION

A. Construction or use of any type of underground injection, including dry wells and stormwater injection wells, is prohibited without prior written approval from the Port. If allowed, the Subcontractor shall be solely responsible for ensuring that the injection systems comply with

Oregon Underground Injection Control (UIC) rules as regulated by the Department of Environmental Quality.

3.3 DEWATERING OPTIONS

A. The Subcontractor may select from the following options. The range of dewatering options is not intended to exclude the use of open pumping with sumps and ditches.
   1. Option 1, Land Disposal:
      a. Discharge water from dewatering operations to the ground surface for eventual infiltration or evaporation as long as effluent has no indications of contamination (e.g. sheen, odor, etc.). Contain water in a natural or created basin or swale approved by the Port. If satisfactory containment cannot be achieved, utilize Option 2.
   2. Option 2, Storm Sewer System Disposal:
      a. Discharge water from dewatering operations to the storm sewer system as long as the effluent looks clean.
      b. At the Port's request, provide a discharge sampling site with reasonable access located where water leaves the construction area. Notify the Port at least 24 hours before the sampling site is ready. Assist the Port in obtaining effluent samples at least 48 hours prior to the beginning of dewatering activities. Do not begin dewatering operations, except for Port sampling purposes, until notified by the Port.

3.4 SUSPECTED CONTAMINATION

A. If, during the course of dewatering, pollutants that are above allowable limits as defined in the Port's Batch Discharge Permit (BDP), permit number 400.131 issued by the City of Portland (COP), are found in any sample or indicated by visual inspections, the Subcontractor shall stop dewatering and notify the Port immediately. The Subcontractor shall not resume discharge until authorized by the Port. The Port will obtain effluent samples for testing per the BDP. The Subcontractor shall follow the provisions of the COP BDP. Place contaminated water in a holding tank equipped with baffles, weir, or other Port-approved form of oil-water separator. Once analytical results are received that meet the conditions of the BDP, discharge the water from the holding tank to a Port-designated sanitary sewer manhole. No product or sheen will be allowed to be discharged. Discharge shall be metered by the Subcontractor for the Port's payment to COP. The Subcontractor shall continue to perform daily inspection of the effluent to confirm the effectiveness of treatment and determine the water's cleanliness.

3.5 DEWATERING OPERATIONS

A. Dewatering well installation, maintenance, and abandonment shall be in accordance with applicable laws and regulations.

B. Control ground water in a manner that will preserve the strength of the bottom soils of trenches and excavations, will not cause instability of the excavation slopes, and will not result in damage to existing structures.

C. Lower the ground water level before beginning excavation using wells, wellpoints, or similar methods. Maintain the drawdown water level at least 12 inches below the bottom of the trench until the trench is backfilled to the original ground water level.

D. Open pumping with sumps and ditches will not be permitted if it results in boils, loss of fines, softening of the ground, or instability of slopes.

E. The Subcontractor is responsible for dewatering, including the adequacy of the dewatering system. Keep trenches and excavations free of water and provide adequate pumping and piping equipment to handle and dispose of water.

F. Provide adequate screens or plugs to prevent objectionable material from entering the downstream storm sewer system. Provide adequate screens or filters so that continuous pumping of fines does not occur.

3.6 WATER QUALITY MONITORING

A. The Port may collect and analyze samples of water produced during dewatering activities to verify the quality of the water, and to determine if the Subcontractor's disposal methods are in compliance with applicable permits, or water quality regulations of the State of Oregon.
   1. If testing indicates the discharge is unacceptable for water quality parameters that the Subcontractor is required to control or should have reasonably anticipated in his bid, including but not limited to, turbidity and suspended solids, the Subcontractor shall bring the discharge into conformance with the requirements. The Port reserves the right to suspend the Subcontractor's work, or prohibit the discharge of water failing to meet the requirements until such time as the Subcontractor demonstrates conformance with the discharge requirements.
   2. If testing indicates the discharge is unacceptable for water quality parameters that the Subcontractor could not have reasonably anticipated in his bid, the Subcontractor shall prepare a revised dewatering plan that identifies the additional methods that will be employed to bring the discharge into conformance with the requirements.

END OF SECTION 31 23 19

SECTION 31 62 18 – FOUNDATION PILING (STEEL PIPE PILES)

PART 1 - GENERAL

1.01 SUMMARY

A. Work under this Section consists of furnishing all labor, equipment, and materials necessary to install all foundation piling for the structures as indicated for Portland Port PDX Fuel Facilities Phase 2 Upgrades.

B. Unless otherwise indicated, minimum design pile capacities shall be as follows:
   1. Tank- 18-inch diameter piles (131-ft embed)
      a. The design seismic compressive capacity of each pile shall not be less than 250 kips, unless otherwise noted.
      b. The design lateral capacity of each pile shall not be less than 23 kips, unless otherwise noted.
   2. HCTS / Ops Building- 18-inch diameter piles (101-ft embed)
      a. The design seismic compressive capacity of each pile shall not be less than 155 kips, unless otherwise noted.
      b. The design lateral capacity of each pile shall not be less than 17 kips, unless otherwise noted.
   3. Above Ground Utility Racks- 18-inch diameter piles (85-ft embed)
      a. The design seismic compressive capacity of each pile shall not be less than 71 kips, unless otherwise noted.
      b. The design lateral capacity of each pile shall not be less than 23 kips, unless otherwise noted.

C. *Minimum required pile penetration depths were determined under seismic design conditions. Anticipated driving conditions are expected to require significantly higher hammer energy requirements to reach depth.*

D. Contractor and/or Subcontractor shall visit the Site prior to bidding to observe and review specific Site conditions and requirements for equipment, methods, and costs to install piling. Contractor shall become familiar with conditions present at the Site prior to bidding; specifically should there be limited access dimensions, utility offsets, headroom clearances, or other conditions which restrict the use of particular driving equipment and thereby affect the associated minimum final driving resistance.Subcontractor shall verify the location of all underground conduits, piping, duct banks, and utilities prior to pile driving.

1.02 REFERENCE STANDARDS
A. Section 31 08 13 - Static Pile Load Testing.
B. Section 31 08 17 - Dynamic Pile Testing.
C. Section 03 30 00 – Concrete.

D. General:
   1. Standards listed by reference, including revisions by issuing authority, form a part of this Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
   2. Where specifications and reference documents conflict, the Contractor shall make the final determination of applicable document.
   3. Unless otherwise noted, the latest revision of the following reference standards shall apply to this Section.

E. Applicable Standards:
   1. ASTM International:
      a. A53–Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      b. A252 –Welded and Seamless Steel Pipe Piles.
   2. American Welding Society (AWS):
      a. D1.1 - Structural Welding Code.
      b. Qualify all welders, welding processes and procedures in accordance with AWS "Code for Welding in Building Construction."
   3. IBC (2018).

1.03 EXPERIENCE QUALIFICATIONS

A. The Subcontractor to perform work shall have a minimum of five (5) years' experience installing the type of piles proposed for the project.

B. The name of proposed Subcontractor performing the work along with their experience statement of past work shall be submitted at time of Bid and will be considered in the evaluation of Bids.

C. All other guidelines for submitting Subcontractor information shall be followed in accordance with that specified elsewhere under "INSTRUCTIONS TO BIDDERS."

1.04 SUBMITTALS

A. Submit as specified in DIVISION 01.

B. Design and Pre-Construction Submittals:
   1. Submit details of pipe pile section; including outside diameter, minimum wall thickness, yield strength, concrete fill material, bearing plate, and anchorage steel, if used.
   2. Submit details of proposed pile driving equipment to Contractor at least three (3) weeks prior to driving piling. The information shall include:
      a. Make and model of pile driving hammer and mandrel, if used, ram weight, stroke and proposed fuel setting, if applicable.
      b. Weight, stiffness, and coefficient of restitution of capblock assembly, cushion dimensions, type of cushion material, and cushion stiffness.

c. Weights and dimensions of mandrels for steel pipe piles along with location and type of splices, if present.
d. Subcontractor's Dynamic Testing consultant shall submit preliminary WEAP analysis and preliminary pile driving criteria.

3. Proposed location and type of splices, if present.
4. Preconstruction Wave Equation Analysis.
5. Detailed description of Vibration Monitoring Program.
6. Pile Driving Layout and Sequence Plan.

7. Details of proposed Test Pile Program, as specified herein and in the applicable Pile Load Testing Section(s).

C. Construction and Closeout Submittals:
1. Submit steel pile driving logs to Contractor within 24-hours after installation of each day's piling. During pile driving, including the installation of the test pile and reaction piles, submit daily to Resident Project Representative, in triplicate, a record of each pile driven and include:
a. Name of structure.
b. Pile cap number.
c. Pile number.
d. Driven pile length.
e. Pile length after cutoff.
f. Elevation of pile tip and cutoff.
g. Ground surface elevation during driving.
h. Date and time of day pile is driven.
i. Continuous driving resistance and pressure gauge readings or hammer stroke.
j. Hammer speed.
k. Location and type of splice, if present.
l. Final driving resistance and pressure gauge readings or hammer stroke.
m. Driving time.
n. Predrilling diameters and depths, as required.
o. Heaving records.
p. Redriving data.
q. Details of concrete placement and concrete strength test results.
r. Remarks concerning installation of piling.
2. As-Built Pile Location and Elevation Data.
a. Submit to Resident Project Representative prior to final payment.
3. Vibration Monitoring Records.
a. Submit to Contractor within 24 hours of testing.
4. Records from Test Pile Program.
5. Submit to Resident Project Representative within 24 hours of testing.

1.05 QUALITY ASSURANCE

A. Geotechnical Representative: The Geotechnical Representative shall be a graduate geotechnical engineer, graduate geologist, or geotechnical technician provided the technician has at least 5 years of relevant experience with the observation of driven pile installation. The Geotechnical Representative will be retained by the Contractor. The Geotechnical

Representative is responsible for observation and recording of material verification, steel pipe pile installation sequence and methods, and other quality control documentation.

B. All driven piles shall be installed in the presence of the Geotechnical Representative. The designated Geotechnical Representative shall have the right to access all field installation records and test reports.

C. SubContractor shall hire a Dynamic Testing Consultant to perform pile drive analyzer (PDA) and CAPWAP at select piles during production piling as indicated in Section 3.14 below. Dynamic Testing Consultant shall be certified as noted within this specification as well as in Section 31 08 17 - Dynamic Pile Testing.

D. Where applicable, Subccontractor shall hire a Static Load Testing Consultant to prepare all pertinent load testing apparatus details and determine test pile performance where indicated. Static Load Testing Consultant shall be certified as noted within this specification as well as in Section 31 08 13 – Static Load Testing.

E. Where applicable, the Subcontractor shall hire a separate, certified firm to perform settlement monitoring during pile driving. The firm hired to perform settlement monitoring shall satisfy the certification requirements relative to the technical aspects of construction. Certification documents shall be provided upon request to the Contractor.

F. The Subcontractor shall hire a separate, certified firm to perform vibration monitoring during pile driving. The firm hired to perform vibration monitoring shall satisfy the certification requirements relative to the technical aspects of construction. Certification documents shall be provided upon request to the Contractor.
   1. The vibration monitoring specialist shall have a minimum 3 years of demonstrated experience, directly related to driven pile operations and other demonstrated experience of satisfactory performance on previous projects.
   2. All equipment shall have been calibrated within 6 months of use on the current project. Calibrations shall have been performed by the manufacturer or their authorized agents.

PART 2 - PRODUCTS

2.01 DRIVEN STEEL PIPE PILES

A. Piles shall be top-driven, concrete-filled steel pipe conforming to ASTM A53 orA252, Grade 50.
   1. Outside diameter shall be 18 inches.
   2. Wall thickness shall be 0.5-inches.

B. The tip shall be closed with a 3/4-inch-thick flat steel plate equal to or less in diameter than the outside diameter of the pile, or other approved devices, continuously welded to the outside of the pipe and capable of withstanding all driving forces and earth pressures without separation. Weld shall be watertight.

C. Store on platforms, skids, or other supports at the Site and support to prevent excessive deflection.

D. The pile assembly shall be watertight after driving.

2.02 CONCRETE FOR INTERIOR OF STEEL PIPE PILES:

A. Fill piling with concrete of minimum compressive strength at 28 days of 6,000 psi as specified in SECTION 03 30 00 - CONCRETE except as follows::

1. The slump of the concrete shall not be less than 4 inches or more than 6 inches.
2. One set of six test cylinders for not less than one day's concrete placement or each 25 cubic yards of concrete or faction thereof or as directed by Resident Project Representative will be prepared by the testing laboratory retained by the Contractor. Test cylinders will be tested for compressive strength.
3. For mandrel-driven pipe piles or piles designed for concrete to carry significant load, one set of six test cylinders shall be taken for each truck load of concrete or as directed by Resident Project Representative.
4. Concrete placement shall conform to ACI 304R, 305.1 and 306.1.

2.03 ANCHORAGE STEEL FOR UPLIFT

A. Attach anchorage steel to steel pipe pile as indicated.

B. Anchorage steel shall comply with quantity, lengths, and connection methods as noted on the Drawings.

2.04 PILE DRIVING EQUIPMENT

A. Pile Driving Hammer:
1. Piles shall be driven with an approved single, partial double-acting or double-acting air, diesel or hydraulic hammer with minimum driving energy and ram weight as required to install the pile to the required penetration depth and ultimate capacity without overstressing the pile.
2. Subcontractor shall submit details of the pile hammer and a Preconstruction WEAP Analysis to Contractor for approval at least two weeks prior to the driving of any piles.
3. Should a change in hammer or driving equipment be necessitated by Subcontractor, the Subcontractor shall submit these revised details and revised WEAP analysis to Contractor for approval at least two weeks prior to driving piles with revised equipment.
4. The pile driving hammer shall be operated at all times at speeds and conditions recommended by the hammer manufacturer.
5. The compressor capacities for air-operated hammers shall be sufficient to operate the hammer continuously at the full-rated speed and energy.
6. For air-operated pile hammers, Subcontractor shall provide a pressure gauge to be located on the hammer air line in such position that it can be clearly read by the pile driver operator.
7. For all partial double-acting and double-acting hammer types, the Subcontractor shall provide the applicable pressure gauge(s) to be located in a position such that it can be

clearly read by the pile driver operator and Resident Project Representative to permit determination of the chamber pressure.

8. For all single-acting hammer types, the Subcontractor shall mark the ram such that it can be clearly read by the pile driver operator and Resident Project Representative to permit determination of the stroke.
9. Unless otherwise approved by Contractor in writing, the pile driver shall be equipped with fixed leads and/or template, secured to the pile driving rig with rigid bracing, and extending to the lowest point which the hammer must reach to drive the piles.
10. Pile driving hammer and driving equipment used for installation of production piles shall be the same equipment (including speeds, fuel/energy settings, and conditions) as that used for installation of the indicator piles, if required, unless otherwise approved by Contractor.

B. Capblock and Cushion:

1. Piles shall be protected during driving by a capblock-and-cushion assembly of approved design.
2. The capblock or cushion materials shall be replaced during driving if it has been damaged, highly compressed, charred, burned, or has become spongy or deteriorated in any manner.
3. Continuous or frequent introduction or addition of cushion materials shall not be permitted.
4. The driving helmet or capblock shall fit flush with the plane of the pile end so that a uniform impact force is applied to the pile during driving.
5. The cushion shall be fabricated from durable materials with referenced elastic and stiffness value properties. The cushion stiffness shall be determined as:

$$S = (AE) / L$$

where:

S = Cushion stiffness (kip/in)
A = Cushion area (in^2)
E = Secant modulus of elasticity of cushion material (ksi)
L = Length or height of cushion (in)

6. The coefficient of restitution of the capblock-and-cushion assembly shall not be less than 0.8.
7. Subcontractor shall submit to Contractor, for approval, details concerning the stiffness of the cushion assembly, the coefficient of restitution, and the weight of the capblock-and-cushion assembly at least two weeks prior to driving piles.

PART 3 - EXECUTION

3.01 PRECONSTRUCTION WAVE EQUATION ANALYSES:

A. Perform wave equation analysis based on proposed pile hammer, capblock and other project specific equipment to be utilized to show proposed equipment is adequate for the project. Use the U.S. Department of Transportation, Federal Highway Administration Wave Equation Analysis of Pile Driving (WEAP) approach for this evaluation.

B. The minimum final driving resistance shall be determined by Subcontractor's Dynamic Consultant/Engineer using the U.S. Department of Transportation, Federal Highway

Administration Wave Equation Analysis of Pile Driving (WEAP) for the pile hammer and associated capblock-cushion materials and properties, as to be submitted and utilized for pile driving by Subcontractor.

C. Proposed driving system shall be shown by the wave equation analysis to develop ultimate pile capacities as identified in this Section at an acceptable driving resistance not greater than 10 to 20 blows per inches and within allowable driving stress limits.

D. The maximum internal stresses during driving shall be limited to the following based on the yield stress of steel:
   a. Compressive Stress: 0.9 x F_y
   b. Tensile Stress: 0.9 x F_y

E. The preconstruction wave equation analysis shall be submitted to Contractor for review.

F. Final determination of appropriate equipment, driving procedures and final driving resistance shall be made as part of the Dynamic Pile Testing of indicator piles. These final results will be applied to the remaining production piles.

3.02 EQUIPMENT FOR DRIVING STEEL PIPE PILES:

A. All pile driving equipment shall be subject to Resident Project Representative's approval after inspection at the Site.

B. At any time during the progress of the Work, equipment that, in the Resident Project Representative's opinion, is unsuitable or in poor operating condition, will not be approved for pile driving.

3.03 FIELD MARKING AND ELEVATIONS:

A. Provide elevation reference and mark each pile along its entire length at 1-foot intervals and along at least the last foot of driving at 1-inch increments, so as to permit determination of the pile tip elevation and corresponding driving resistances during driving.

3.04 DRIVING PROCEDURE:

A. Piles shall not be driven until inspected and approved for driving.

B. Piles shall be driven using an impact hammer. Vibratory installation methods are not permitted.

C. Each pile shall be driven continuously and without voluntary interruption until the specified penetration length and driving resistance have been obtained.

D. Piles shall be driven in contact with surrounding soil and left permanently in place.

E. Piles shall be driven in a sequential operation which will minimize heaving of adjacent piles.

F. Pile driving operations shall be suspended if impact shock results in problems to any adjacent structures or equipment until corrective measures can be taken.

G. No pile shall be driven within 10 feet of any previously driven pile where concrete has been placed less than 8 hours prior.

H. No method requiring force to correct the position or line of any pile shall be permitted during driving.

I. Special precautions shall be taken to avoid oil spatter from pile driving equipment when working near existing structures, vehicles, and other permanent fixtures.

J. After completion of driving each pile, the pile shall be kept covered continuously to prevent debris and foreign materials from falling into the pile prior to the placement of concrete.

K. Pile driving areas shall be kept free from water at all times.

3.05 VIBRATION MONITORING:

A. Perform vibration monitoring on adjacent structures or other facilities subject to damage from pile driving, as directed. Vibration monitoring shall cover distances from 10-feet to 100-ft away from driving operations.

B. A separate, certified firm shall be provided to:
   1. Determine locations to set up seismographs, or where to position during various stages of pile driving activities.
   2. Measure background vibration response and air response noise prior to commencing driving.
   3. Perform background monitoring during construction at times corresponding to those times of proposed driving operations.
   4. Monitor driving operations at necessary locations throughout all driving operations.
   5. Provide a permanent record from each seismograph, referencing location of seismographs and distance away from driving operation.
   6. Use a minimum of two seismographs capable of detecting peak particle velocities in three mutually perpendicular components, otherwise known as the x, y, and z axes.
   7. Use a minimum of two seismographs capable of recording amplitude (peak particle velocity) and frequency (hertz). Displacement shall be developed, if needed for frequencies as required, from empirical computer relationships.
   8. Peak particle velocities and/or displacements at adjacent structures, equipment, exposed or buried, pipelines and conduits shall not exceed the level of criteria as determined by U.S. Department of Interior, Bureau of Mines in Appendix Figure B-1 from Report of Investigations 8507 by D.E. Siskind, et al.

C. Contractor shall take appropriate corrective actions to prevent damage to adjacent structures, pavement, utilities, and other improvements.

3.06 PENETRATION AND DRIVING RESISTANCE:

A. Piles shall be driven to 131 feet of embedment and then to the specified and minimum driving resistance.

B. The minimum final driving resistance shall be determined by Subcontractor's Dynamic Consultant/Engineer and approved by the Contractor using the U.S. Department of Transportation, Federal Highway Administration Wave Equation Analysis of Pile Driving (WEAP) for the pile hammer and associated capblock-cushion materials and properties, as to be submitted and utilized for pile driving by Subcontractor and as determined in conjunction with the Indicator Test Pile Program.

3.07 SPLICING:

A. Splice pile assembly before driving to produce a length adequate for anticipated penetration.

B. If the length of a pile assembly is insufficient to achieve the specified penetration and driving resistance, extend the driven assembly by splicing an assembly of the same cross section.

C. Piles shall not be spliced in the upper 30-ft.

D. Welding shall not be performed when the temperature of the base metal is lower than 0° F. At temperatures between 32° F and 0° F, the surface of all areas within 3 inches of the area where the weld is to be performed shall be heated uniformly to a temperature at least warm to the hand before any welding is done.

E. Splices shall be accurately aligned, watertight, and welded as follows:
   1. Shielded arc, fusion welded in conformance with "Standard Code for Arc and Gas Welding in Building Construction" by the AWS D1.1.
   2. Executed by welders presently qualified the AWS "Standard Qualification Procedure."
   3. 100% butt welded using a 45 single-bevel weld backed up on the far side.
   4. Using mild steel electrodes conforming to AWS specification E70 series.

F. After welding, permit sufficient time for weld to cool to touch prior to continuation of pile driving.

G. After splicing, piles shall be driven to the specified penetration and driving resistance.

H. Only one splice per pile shall be permitted.

3.08 HEAVING:

A. Heaving shall be checked on a selected reference pile within each pile group or cluster.

B. The reference pile shall be checked by comparison of elevations before and after driving of all adjacent piles within a group or cluster.

C. Heaving shall be considered as occurring to all piles within a group or cluster when the reference pile head elevation changes in excess of 0.025-foot.

D. Piles within a group or cluster shall be redriven when the reference pile heaves in excess of 0.025-foot.

3.09 REDRIVING:

A. A pile selected by Contractor from within the initial pile group or cluster driven shall be redriven not less than 4 hours and preferably 24 hours after completion of initial driving in order to check for relaxation or freeze. Relaxation is indicated by a lesser number of blows per inch required to mobilize the pile than was attained at completion of its original final driving resistance.

B. Piles shall be driven to re-establish final elevation, after the hammer has warmed up. Driving resistance shall be noted for each inch of pile penetration. If redriving indicates relaxation, Contractor shall be notified. All piles within a pile group or cluster which has indicated relaxation shall be redriven until the driving resistance for the last inch indicates that specified pile capacities have been attained.

C. Redrive all piles within a group or cluster that have indicated heave of the reference pile.

3.10 CUTOFF:

A. Piles shall be cut off perpendicular to the vertical axis of the pile and to within 1-inch of the cutoff elevation indicated.

B. Piles shall be cut off by methods which will not damage reinforcing steel and/or concrete of the pile left in place. Where applicable, cut off steel pipe pile before installation of pile cap reinforcing steel and concrete.

C. Portions of pile which are battered, split, warped, buckled, damaged, or imperfect within the upper reaches of the top shall be cut off. This does not apply to piles that have been rejected.

D. If excavation around the piles is required to achieve pile cut off, the excavated material shall be removed and disposed of as directed by Contractor.

E. Remove waste steel pipe, reinforcing steel, concrete, and dispose of off-site or as otherwise directed by Contractor.

3.11 INSTALLATION TOLERANCES:

A. Piles shall not exceed a variation from the vertical axis of the pile of more than 1/4-inch per foot of pile length.

B. Piles shall not exceed a sweep in which one side of the pile tip is not visible from the ground surface, unless otherwise approved in writing by Contractor.

C. The center of the pile head shall not vary from plan location at cutoff by more than 3 inches.

D. Piles shall be cut off and concrete placed to within 1-inch of the cutoff elevation indicated.

3.12 ANCHORAGE STEEL PLACEMENT:

A. Remove all foreign matter from pile prior to attaching anchorage steel.

B. Anchor for uplift as indicated.

C. Anchorage steel shall not be attached to piles until after initial inspection by Resident Project Representative. Anchorage steel shall not be attached to rejected piles.

3.13 CONCRETE PLACEMENT:

A. Remove all foreign materials, including water, sand, mud, or debris from the pile prior to concrete placement. Concrete shall be placed only in piles without water, unless pumping or other placement methods are approved in writing by Contractor.

B. Do not place concrete within the pile until pile is inspected by Resident Project Representative using a light suitable for inspection of the entire length of the pile. Light, tape, and plumb weight shall be provided by Subcontractor.

C. Concrete shall be placed in the pile as soon as possible after driving, consistent with Subcontractor's operations. Water and/or foreign materials shall not be allowed to accumulate in the pile.

D. Do not place concrete into any pile within an area indicated as heaved until redriving has been performed.

E. Place concrete by methods and equipment which will prevent segregation, arching, or formation of voids in the concrete.

F. Place concrete continuously in each pile from pile tip to pile cutoff elevation without interruption.

G. Vibrate or rod concrete within the upper 15 feet of the pile to promote complete consolidation of concrete.

H. Concrete shall be placed in accordance with SECTION 03 30 00 - CONCRETE.

3.14 NON-CONFORMING WORK:

A. Subcontractor shall be solely responsible for full compliance with the Contract Documents regardless of if and when discrepancies are brought to their attention. Subcontractor shall be responsible for all re-work necessary to achieve full compliance with the Contract Documents. Repairs or replacement shall be at the sole expense of the Subcontractor, including the costs to redesign, as required.

B. Contractor may employ one or more of their representatives to provide observation and testing services.

C. Contractor may reject any piles which, in their opinion, do not conform to the Contract Documents.

D. As directed by Contractor, perform the following for rejected piles at no additional cost to Contractor:
   1. Leave piles in place, cut off as directed, and install one or more replacement piles in designated location(s).
   2. Withdraw the pile and install a new pile in the same location. Any holes which result from pile withdrawal shall be packed with sand, controlled low strength material (CLSM), gravel, or other approved material prior to installation of the replacement pile.
   3. Other remediation work, as directed.

3.15 REJECTED PILES:

A. The Resident Project Representative will determine the acceptability of all piles driven and may, at their option, reject those piles which do not conform to the Drawings and Specifications.

B. As directed by Resident Project Representative, Subcontractor shall perform one of the following for rejected piles:
   1. Leave piles in place, cut off as directed, and drive one or more new piles in locations designed by Resident Project Representative to replace the rejected pile and maintain symmetry of the pile group or cluster.
   2. Withdraw the pile and drive a new pile. Any holes which result from pile withdrawal shall be packed with sand, gravel, or other approved nonplastic (noncohesive) soil before redriving of the replacement pile.

3.16 TEST PILE PROGRAM:

A. Indicator Piles:
   a. Install ten (10) total Driven Steel Pipe Indicator Piles at locations representative of each of the following structures:
      (1) Seven (7) at the Tanks (131-ft embedment, east / south side of site)
      (2) Two (2) at the HCTS Structure (101-ft embedment, north side of site)
      (3) One (1) at the Utility Racks (75-ft embedment, east / south side of site)

   a. Install five (5) Helical Torque Steel Pipe Indicator Piles within ten feet of the following Driven Steel Pipe Indicator Piles:
      (1) Four (4) near driven locations selected for the Tanks (131-ft embedment, east / south side of site)

(2) One (1) near a driven location selected for the HCTS Structure (101-ft embedment, north side of site)

2. During the Indicator Program, Subcontractor shall install settlement monitoring points 10, 25, 50 and 100 feet from driving operations. Record elevations prior to driving, and at 1-, 3- and 7-days following installation activities.
3. The installation equipment (hammer, cushion, cap-block, follower) and methods during the driving of the indicator piles shall be the same (including speeds, fuel/energy settings, and conditions) as that used for production pile driving. Each additional hammer and equipment setup including one of identical make and model shall require performance evaluation (including Pile Driving Analyzer) and Contractor's subsequent approval.
4. Indicator piles shall be installed in accordance with procedures required for production piles and Subcontractor shall submit to Resident Project Representative a record of each indicator pile placed including all information required for production piles.
5. Remaining production piles shall not be driven until evaluation of indicator piles has been completed by the Contractor
6. Subcontractor shall secure the services of a Dynamic Testing Consultant.
7. Dynamic pile testing shall be conducted on all indicator piles during the entire duration of initial driving and during restrike driving operations.
8. Restrike driving shall be performed a minimum of 72 hours following completion of initial pile installation and prior to placing concrete in the piles.
9. The Contractor shall maintain sufficient pile head exposure at the end of initial driving on production piles to permit the attachment of the dynamic testing sensors. This may be accomplished with either additional pile length or small excavations to expose the pile head.
10. CAPWAP analysis of the dynamic pile testing data shall be performed on data obtained from the end of initial driving and the beginning of restrike driving for all indicator piles.
11. Dynamic pile load testing shall be performed only in the presence of the Contractor.
12. The Contractor will select the following quantity of indicator pile(s) to be statically load tested in each respective mode (test piles):
    a. Driven Steel Pipe Piles
        (1) Three (3) piles under axial compression loading.
        (2) No piles under axial tension loading.
        (3) Two (2) piles under lateral loading.
    b. Helical Toque Steel Pipe Piles
        (1) Three (3) piles under axial compression loading.
        (2) No piles under axial tension loading.
        (3) Two (2) piles under lateral loading.
13. At Subcontractor's discretion, individual indicator piles may be used for all modes of static testing (axial compression, and lateral). The required sequence of static load tests is axial compression, then lateral.
    a. Tank Piles (131-ft embedment)
        (1) Axial Compression: 476 tons.
        (2) Axial Tension: No tension testing
        (3) Lateral: 23 tons.
    b. HCTS Piles (101-ft embedment)
        (1) Axial Compression: 336 tons.
        (2) Axial Tension: No tension testing
        (3) Lateral: 17 tons.
    c. Utility Rack Piles (75-ft embedment)

(1) Axial Compression: 215 tons.
(2) Axial Tension: No tension testing
(3) Lateral: 23 tons.

14. Excessive Test Pile Movements:
    (1) If excessive pile movement (i.e. failure) occurs prior to reaching the maximum anticipated test load under compression loading, continue jacking the pile until the total vertical movement equals 15% of the pile butt diameter.
    (2) If excessive pile movement (i.e. failure) occurs prior to reaching the maximum anticipated test load under lateral loading, continue jacking the pile until the total lateral movement equals 2 inches.
15. Static pile load testing shall be performed only in the presence of the Contractor.
    (1) The Contractor shall perform a comparative analysis of the load-deflection plot from the lateral load test and the theoretical performance from the original design LPILE model. This comparative analysis shall assume negligible axial loading and a free head condition for the test pile.
        (a) The design capacity shall be verified by confirming that the test pile performance meets or exceeds the theoretical design performance under these same conditions.
        (b) If the test pile deflects more than predicted from the original LPILE model, then the model shall be fitted to the test pile data utilizing appropriate p-multipliers for the soil layers. The refined LPILE model shall then be used to model the pile under anticipated design conditions (design axial loading, partial pile head fixity, changes in grade, changes in long term groundwater conditions or other changes from design conditions as applicable, etc.) to develop revised lateral capacities for the production piles.

END OF SECTION 31 62 18

SECTION 32 12 00 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the construction of one or more courses of dense graded hot-mix asphalt concrete (HMAC) pavement, plant mixed into a uniformly coated mixture, hot laid on a prepared foundation, compacted to specified density, and finished to a specified smoothness to the lines, grades, thickness, and cross-sections shown on the drawings.

B. The Subcontractor may use warm mix asphalt concrete (WMAC) as a substitute for HMAC on all lifts. WMAC will be subject to all requirements for HMAC specified, except as modified in this section. The term WMAC is interchangeable with HMAC throughout this section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01 57 13, Temporary Erosion, Sediment, and Pollution Control

B. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

1.3 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials
   1. AASHTO T11: Test for Materials Finer Than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
   2. AASHTO T27: Test for Sieve Analysis of Fine and Coarse Aggregates
   3. AASHTO T90: Test for Determining the Plastic Limit and Plasticity Index of Soils
   4. AASHTO T104: Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
   5. AASHTO T113: Lightweight Pieces in Aggregate
   6. AASHTO T176: Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
   7. AASHTO T209: Test for Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt (HMA)
   8. AASHTO T283: Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
   9. AASHTO T308: Test for Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method
   10. AASHTO T329: Standard Method of Test for Moisture Content of Hot-Mix Asphalt (HMA) by Oven Method
   11. AASHTO T335: Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate

B. ASTM: American Society for Testing and Materials
   1. ASTM C1097: Hydrated Lime for Use in Asphalt Cement or Bituminous Pavements

2. ASTM D1417: Standard Test Methods for Rubber Latices-Synthetic
3. ASTM D2041: Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

C. ODOT: Oregon Department of Transportation
   1. Oregon Standard Specifications for Construction
      a. ODOT Section 00730: Emulsified Asphalt Tack Coat
   2. Laboratory Manual of Test Procedures
      a. ODOT TM 208: Oregon Air Aggregate Degradation
   3. Supplemental Test Procedures for HMAC and EAC
      a. ODOT TM 319: Preparation and Characterization of Recycled Asphalt Materials for Mix Design
   4. Manual of Field Test Procedures
      a. ODOT TM 225: Presence of Wood Waste in Produced Aggregates
      b. ODOT TM 229: Determination of Elongated Material in Coarse Aggregates
      c. ODOT TM 305: Calculating the Moving Average Maximum Density (MAMD)
      d. ODOT TM 306: Performing a Control Strip for HMAC Pavement
      e. ODOT TM 321: Asphalt Content of Bituminous Mixtures by Plant Recordation
      f. ODOT TM 323: Determination of Calibration Factors for Determining Asphalt Cement Content of HMAC by Ignition Method
   5. ODOT Contractor Mix Design Guideline

1.4 DEFINITIONS

A. Base Course: All lifts of HMAC not classified as wearing course.

B. CAT II: Certified Asphalt Technician II.

C. CMDT: Certified Mix Design Technician.

D. Gmm: Maximum specific gravity of mixture.

E. Hot-Mixed Asphalt Concrete (HMAC): A hot plant-mixed, uniformly coated mixture of asphalt cement, graded aggregate, and additives as required.

F. JMF: Job mix formula.

G. Level 3 HMAC: HMAC for use in applications exposed to moderate truck traffic.

H. Lot: A lot is the total quantity of material produced per day. The following circumstances will require a different lot:
   1. A new JMF is used. A JMF adjusted according to these specifications is not considered a new JMF.
   2. The Contractor may allow material for irregular areas not completed during the main paving operations, such as driveways or guardrail flares to be evaluated as a separate lot.
   3. The Contractor may elect to combine up to two days' work into a single lot when small quantities are expected.
   4. When more than one plant is simultaneously producing material for the job, the lot sizes shall apply separately for each plant.

5. If one day's production exceeds 2,000 tons, a new lot will be designated.
6. A new lot will be established for WMAC technology.

I. Maximum Density Test (MDT): The theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041, by 62.4 pounds per cubic foot.

J. MDV: Mix design verification.

K. MFTP: Manual of Field Test Procedures (ODOT).

L. PWL: Percent within limits

M. QPL: ODOT Qualified Products List

N. RAP: Reclaimed asphalt pavement.

O. Sublot: A sublot is 500 tons of HMAC.

P. Surface Damp Condition (SDC): When the outside of the aggregates are damp with moisture, but little or no free water is present.

Q. TSR: Tensile strength ratio.

R. VFA: Voids filled with asphalt.

S. VMA: Voids in mineral aggregate.

T. Warm Mix Asphalt Concrete (WMAC): An asphalt concrete mix following all requirements of HMAC, except that through the use of approved additives or processes, it is mixed, placed, and compacted at lower temperatures.

U. Wearing Course: The top lift of HMAC, regardless of thickness.

1.5 SUBMITTALS

A. Submit aggregate qualification tests for aggregate used in HMAC.

B. Submit a mix design and job mix formula for HMAC 15 days prior to the start of production of the paving mixture. Formula shall include the items identified in these specifications.

PART 2 - PRODUCTS

2.1 RECLAIMED ASPHALT PAVEMENT (RAP) MATERIAL

A. Reclaimed HMAC pavement (RAP) material used in the production of new HMAC is optional. No more than 30 percent RAP will be allowed in base courses. No more than 20 percent RAP

will be allowed in Level 1 and Level 2 wearing courses. No RAP will be allowed in Level 3 and Level 4 wearing courses.

B. The amount of asphalt cement in the RAP shall be established in the mixture design phase according to ODOT TM 319 and the ODOT Contractor Mix Design Guidelines for Asphalt Concrete, or other method approved by the Contractor. Additional testing may be requested at any time by the Contractor or the Subcontractor during the production of the RAP mixture to verify the amount of asphalt cement in the RAP. Conduct new tests by a laboratory mutually agreed upon by the Contractor and the Subcontractor. RAP shall not contain any material containing coal tar such as materials treated with sealers or rejuvenators.

2.2 HOT-MIX ASPHALT CONCRETE

A. Aggregate: Provide and stockpile new aggregates according to the following requirements:

1. General: Produce and stockpile aggregate as follows:

a. Separated Sizes: Advise the Contractor of the separated size(s) of coarse and fine aggregate that will be used and the proposed targets for each individual sieve size for each stockpile. A minimum of one coarse aggregate and one fine aggregate stockpile is required.

1) If the Subcontractor wishes to produce coarse and fine aggregates in separated sizes other than those specified, request the proposed size changes in writing, and state the proposed target value and specified tolerance for each of the individual sieve sizes of the proposed materials.

2) The number of fine aggregate separated sizes selected by the Subcontractor does not relieve the Subcontractor of providing a JMF and producing HMAC meeting the air voids, VMA, and VFA requirements specified. Perform recrushing, rescreening, or other special processing of the fine aggregates as necessary to achieve the air voids, VMA, or VFA requirements.

b. Scalping: Scalp the rock on a 3/4-inch sieve screen deck (after it has passed through the primary crusher if quarry rock is used). The material remaining may be accepted for use by visual inspection. The Contractor may perform verification testing of the gradation. The material shall meet the following:

Sieve Size	Percent Passing (by Weight)
8"	95 - 100
3/4"	5 max.

c. Soundness: Provide coarse and fine aggregate with a weighted loss not exceeding 9 percent when subjected to five cycles of the soundness test using sodium sulfate solution according to AASHTO T 104.

d. Durability: Provide aggregate not exceeding the following maximum values:

Test	Test Method		Aggregates
	ODOT	AASHTO	Coarse
Abrasion		T 96	30.0%
Degradation			
Passing No. 20 sieve	TM 208		30.0%
Sediment height	TM 208		3.0"

e. Fractured Faces: Provide crushed aggregate with not less than the minimum number of fractured faces as determined by AASHTO T 335, as follows:

Percent of Fracture (by Weight)	
Material Retained on 1 1/2", 1", 3/4", 1/2", and No. 4 Sieve (two fractured faces)	Material Retained on No. 8 Sieve (one fractured face)
75	75

f. Harmful Substances: Do not exceed the following values:

	Test Method		Aggregates	
Test	**ODOT**	**AASHTO**	**Coarse**	**Fine**
Lightweight Pieces		T 113	1.0%	na
Wood Particles	TM 225		0.10%	na
Elongated Pieces (at a ratio of 5:1)	TM 229		8.0%	na
Plasticity Index		T 90		0 or NP
Sand Equivalent		T 176		45 min *
* 50 min. for Level 4 HMAC				

2. Coarse Aggregate:
   a. General: Produce coarse aggregate from crushed rock or other inert material of similar characteristics. No aggregates will be allowed that are derived from blast furnace slag.
   b. Separated Sizes: Allowable separated sizes of coarse aggregate are as follows:

Type of Asphalt Concrete Mixture	**Allowable Separated Sizes**			
	1 1/4" - 3/4"	**3/4" - No. 4**	**3/4" - 1/2"**	**1/2" - No. 4**
1" Dense	Yes	Yes	Yes	Yes
3/4" Dense	-	Yes	Yes	Yes
1/2" Dense	-	-	-	Yes

   c. Grading: Determine sieve analysis according to AASHTO T27 and AASHTO T11. Establish the target values for each allowable separated size after a maximum of 10 percent of planned stockpile quantity has been produced. Produce the aggregate within the following listed tolerances (T):

	Separated Sizes			
	1 1/4" - 3/4"	**3/4" - No. 4**	**3/4" - 1/2"**	**1/2" - No. 4**
	Percent Passing (by Weight)			
Sieve Size	**T**	**T**	**T**	**T**
1 1/2"	- 1	-	-	-
1 1/4"	± 5	-	-	-
1"	± 10	- 1	- 1	-
3/4"	± 5	± 5	± 7	-1
1/2"	-	± 8	± 8	± 5
3/8"*	-	-	-	-
No. 4	± 3	± 8	± 8	± 8
No. 8	-	± 5	± 5	± 5

	Separated Sizes			
	1 1/4" - 3/4"	3/4" - No. 4	3/4" - 1/2"	1/2" - No. 4
	Percent Passing (by Weight)			
Sieve Size	T	T	T	T
No. 16*	-	-	-	-
No. 30	± 1	± 3	± 3	± 3
No. 50*	-	-	-	-
No. 100*	-	-	-	-
No. 200	-	± 1.0	± 1.0	± 1.0
* Report percent passing sieve when no tolerance is listed.				

3. Fine Aggregate:
   a. General: Produce fine aggregate from crushed rock or other inert material of similar characteristics and if allowed, blend sand. No aggregates are allowed that are derived from blast furnace slag.
   b. Separated Sizes: Allowable separated sizes for fine aggregates are:
      1) No. 4 - 0
      2) No. 4 - No. 8
      3) No. 8 - 0
   c. Grading: Determine sieve analysis according to AASHTO T 27 and AASHTO T11. Establish the target values for each allowable separate size after a maximum of 10 percent of planned stockpile quantity has been produced. Produce the aggregate within the following listed tolerances (T):

	Separated Sizes		
	No. 4 - 0	No. 4 - No. 8	No. 8 - 0
	Percent Passing (by Weight)		
Sieve Size	T	T	T
3/8"	- 1	- 1	-
No. 4	± 7	± 10	- 1
No. 8	± 7	± 7	± 10
No. 16*	-	-	-
No. 30	± 7	± 5	± 8
No. 50*	-	-	-
No. 100*	-	-	-
No. 200	± 3.0	± 2.0	± 4.0
*Report percent passing sieve when no tolerance is listed.			

   d. Combination of Fine Aggregate for Testing: Blend together fine aggregate produced in two separate sizes at a 1:1 ratio when testing for sand equivalent.
   e. Blend Sand:
      1) No natural or uncrushed blend sand will be allowed in Level 4 HMAC unless approved by the Engineer. Blend sand is allowed for Levels 1, 2, and 3 mixes. For these mixes, establish the target gradation and produce all material within the following tolerances (T):

Sieve Size	Percent Passing (by Weight)
	T
3/8"	-1

Sieve Size	Percent Passing (by Weight)
	T
No. 4	±5
No. 8	±15
No. 30	±20
No. 200	±5.0

2) Determine sieve analysis according to AASHTO T27 and AASHTO T11. Do not use more than 6 percent natural or uncrushed blend sand, by weight, in the total aggregate. Provide a means for verifying and documenting the amount of blend sand added to the aggregate.

4. RAP Aggregate: Use RAP aggregates in the HMAC, as specified herein, that are no larger than the specified maximum allowable aggregate size before entering the cold feed. Blend the RAP material with new aggregate to provide a mixture conforming to the JMF within the tolerances specified.

B. Asphalt Cement: Use PG 70-22 grade of asphalt cement. Provide asphalt cement conforming to the requirements of ODOT's publication, "Standard Specifications for Asphalt Materials."

C. Asphalt Cement Additives:
1. Use standard recognized asphalt cement additive products of known value for the intended purpose and approved for use on the basis of laboratory tests. Asphalt cement additives shall have no deleterious effect on the asphalt material and be completely miscible. Do not use silicones as an additive.
2. Add the following asphalt cement additives when required by the JMF:
   a. Anti-stripping asphalt cement additives to prevent stripping or separation of asphalt coatings from aggregates to satisfy the TSR specified herein.
   b. Asphalt cement admixtures used to aid in the mixing or use of asphalt mixes.
3. When WMAC is used, select one of the WMAC technologies and process and additives types listed below or approved by the Engineer.

WMAC Technology	Process and Additive Type	Supplier
LEA-CO	Foaming Process	Advanced Concepts Engineering Co.
Eco-Foam II	Foaming Process	AESCO/Madsen
Redi-Set WMX	Chemical Additive	Akzo Nobel Surfactants, Inc.
CECABASE RT	Chemical Additive	Arkema Group
Aspha-Min (Synthetic Zeolite)	Foaming Process	Aspha-Min
Double Barrel Green System	Foaming Process	Astec Industries
Green Machine	Foaming Process	Gencor Industries
HGrant Warm Mix System	Foaming Process	Herman Grant Company
Qualitherm	Chemical Additive	Iterchimica
Aquablack Warm Mix Asphalt	Foaming Process	Maxam Equipment Inc.
Low Emission Asphalt	Chemical Additive	McConnaughay Technologies
Evotherm	Chemical Additive	MeadWestvaco Asphalt Innovations
Meeker Warm Mix	Foaming Process	Meeker Equipment Corp. Inc.
Advera (Synthetic Zeolite)	Foaming Process	PQ Corporation

WMAC Technology	Process and Additive Type	Supplier
Sasobit	Organic Additive	Sasol Wax Americas, Inc.
Shell Thiopave	Chemical Additive	Shell
Accu-Shear Dual Warm-Mix Additive System	Foaming Process	Stainsteel
Tri-Mix Warm Mix Injection	Foaming Process	Tarmac Inc.
Warm Mix Asphalt System	Foaming Process	Terex Roadbuilding

4. Submit the proposed WMAC technology to be used and a plan for its implementation.
5. Comply with the manufacturer's recommendations for incorporating additives and WMAC technologies into the mix. Comply with manufacturer's recommendations regarding receiving, storing, and delivering the additives.

D. Aggregate Treatment with Hydrated Lime: Aggregates shall be treated with hydrated lime at the option of the Subcontractor.
   1. When lime-treated aggregate is selected by the Subcontractor, treat new crushed aggregates, except those in RAP materials, with dry hydrated lime meeting the requirements of ASTM C1097. Mix the dry hydrated lime, water (if necessary to achieve surface damp condition), and aggregate in a pug-mill to ensure complete and uniform coating of the aggregate before the aggregate enters the paving plant dryer. The lime proportions and aggregate moisture content shall be as specified below.
      a. Hydrated lime (% by weight of dry aggregate): 1.0
      b. Lime tolerance (% by weight of dry aggregate): -0.2 to +0.5
      c. Moisture content of aggregate: SDC
   2. Determine the quantity of lime in aggregate for each sublot according to ODOT TM 321. If the rates of application specified are not met, take corrective action. Document the corrective action and notify the Engineer.

E. Aggregate Treatment with Latex Polymer: A latex polymer aggregate treatment material may be used to treat new crushed aggregates instead of lime if TSR test results on the mixture with the latex polymer treatment at the JMF meet the minimum criteria specified.
   1. General:
      a. Provide a system to automatically meter the latex emulsion at the proper rate and apply the emulsion uniformly to the aggregate prior to the addition of the asphalt cement. Follow manufacturer's recommendations to set up, adjust and calibrate the equipment.
      b. Demonstrate to the Engineer's satisfaction that the required application rate of latex solids is being met. If it is not, take corrective action. Document and notify the Engineer of the corrective action.
   2. Latex Polymer: Use latex polymer emulsion concentrate meeting the criteria in the table below. Submit a quality compliance certificate for the polymer latex emulsion concentrate.

	Minimum	Maximum	Test Method
Solids Percent	65.0	--	ASTM D 1417
pH	9.0	11.0	ASTM D 1417
Brookfield Viscosity Spindle 3, 20 RPM, cPs	500	3000	ASTM D 1417

3. Application Rate: Apply the latex emulsion to achieve a minimum of 0.75 pounds of latex solids per ton of new aggregate (0.0375%). Higher application rates may be required to meet minimum TSR limits. Determine application rate during mix design testing.
4. Treatment during HMAC Production:
   a. Adjust aggregate moisture content to meet manufacturer's recommendation for emulsion application. Apply the latex emulsion at the minimum rate specified above or at a higher rate if TSR testing indicates a higher rate is required.
   b. Apply the latex emulsion to the aggregate just prior to entry into dryer drum. Mix aggregate with the emulsion in a pugmill or in the dryer drum prior to application of asphalt cement. Heat aggregates to at least 250ºF after treatment and prior to addition of asphalt cement.

F. Mix Type and Broadband Limits: Mix type and broadband limits shall meet the following:
1. Mix Type: Furnish the type of HMAC shown or as directed. The broadband limits for each of the mix types are specified below. When the drawings allow an option of two types for a course of pavement, use only one type throughout the course.
2. Broadband Limits: Provide a JMF for the specified mix type within the control points listed below:

Dense-Graded Mixes		
Sieve Size	**3/4" Dense**	
	Control Points (% Passing by Weight)	
	Min	**Max**
1-1/2"		
1"	100	
3/4"	90	100
1/2"	--	90
3/8"	--	--
No. 4	--	--
No. 8	23	49
No. 200	2.0	8.0

G. Job Mix Formula (JMF) Requirements: Do not begin production of HMAC for use on the project until the JMF is reviewed by the Engineer and written consent is provided to proceed. The JMF proposed for use on the project will be evaluated based on the criteria set forth in this specification and the ODOT Contractor Mix Design Guidelines for Asphalt Concrete. For all mixes, complete TSR testing at least once per calendar year on mix from the first week of production of that JMF for that year. A new JMF is required if the asphalt cement grade, any additives, or the source of the aggregate change during production. A change in the source of asphalt cement only requires a new passing TSR.
1. WMAC Requirements: A separate JMF will be issued for WMAC. When WMAC is used, submit the following information in addition to the requirements for HMAC.
   a. WMAC technology and WMAC additives information.
   b. WMAC technology manufacturer’s established recommendations of usage.
   c. WMAC technology manufacturer’s established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.

d. WMAC technology safety data sheets if applicable.
e. Temperature range for mixing.
f. Temperature range for compacting.
g. Except for foaming technology, asphalt binder performance grade test data of the asphalt binder and chemical additive at the manufacturer's recommended dosage rate.
h. Except for foaming technology, submit WMAC mixture performance test results for Level 3 and Level 4 mixes according to the ODOT Contractor Mix Design Guidelines for Asphalt Concrete. Perform testing for foaming technology on the production mix on specimens compacted at WMAC compaction temperatures.

2. Subcontractor-Furnished JMF: The Subcontractor's CMDT shall prepare, sign, and submit a JMF to the Engineer for each mixture required at least 10 days prior to the anticipated use in HMAC. If requested, submit material samples 10 days prior to use.
3. JMF Requirements: The JMF shall meet the following mixture requirements:

Dense Graded Mixture				
	Level 1	**Level 2**	**Level 3**	**Level 4**
Design Method	Superpave	Superpave	Superpave	Superpave
Compaction Level	65 Gyrations	65 Gyrations	80 Gyrations	100 Gyrations
Air Voids, %	3.5	4.0	4.0	4.0
VMA, % minimum	1/2 in. - 14.0	3/4 in. - 13.0	3/4 in. - 13.0	1 in. - 12.0
	3/8 in. - 15.0	1/2 in. - 14.0	1/2 in. - 14.0	3/4 in. - 13.0
		3/8 in. - 15.0	3/8 in. - 15.0	1/2 in. - 14.0
				3/8 in. - 15.0
VMA, % maximum	min + 2.0%	min + 2.0%	min + 2.0%	min + 2.0%
P No. 200 / Eff. AC ratio	0.8 to 1.6	0.8 to 1.6	0.8 to 1.6	0.8 to 1.6
TSR, % minimum	80	80	80	80
VFA, %	70 – 80 3/8 in.: 70 - 80	65 - 78 3/8 in.: 70 - 80	65 - 75 3/8 in.: 70 - 80	65 - 75 3/8 in.: 70 - 80

H. Performance Testing: For each dense-graded Level 3 wearing course mixes and all dense-graded Level 4 mixes submitted for review:
1. Include the results of performance testing as outlined in the ODOT Contractor Mix Design Guidelines for Asphalt Concrete.
2. Submit test results to the Engineer within 30 days of submitting the mix design for review.

2.3 TOLERANCES AND LIMITS

A. Produce and place HMAC within the following JMF tolerances and limits:

Gradation Constituent	**Dense-Graded HMAC Type**			
	1'	**3/4"**	**1/2"**	**3/8"**
1 1/2"	JMF ±5% *			
1"	90 – 100%	JMF ±5% *		
3/4"	JMF ±5%	90 – 100%	JMF ±5% *	
1/2"	JMF ±5%	JMF ±5%	90 – 100%	JMF ±5% *
3/8"**	--	--	--	90 – 100%
No. 4	JMF ±5%	JMF ±5%	JMF ±5%	JMF ±5%

Gradation Constituent	Dense-Graded HMAC Type			
	1'	3/4"	1/2"	3/8"
No. 8	JMF ±4%	JMF ±4%	JMF ±4%	JMF ±4%
No. 16**	--	--	--	--
No. 30	JMF ±4%	JMF ±4%	JMF ±4%	JMF ±4%
No. 50**	--	--	--	--
No. 100**	--	--	--	--
No. 200	JMF ±2.0%	JMF ±2.0%	JMF ±2.0%	JMF ±2.0%
*Maximum not to exceed 100% **Report percent passing sieve when no tolerance is listed.				

Constituent of Mixture	HMAC - All Types
Asphalt Cement - ODOT TM 321 (Cold Feed/Meter)	JMF ±0.20%
Asphalt Cement - AASHTO T 308 (Ignition) and ODOT TM 323	JMF ±0.50%
RAP Content - ODOT TM 321	JMF ±2.0%
Moisture content at time of discharge from the mixing plant – AASHTO T329 - dense-graded	0.80% max.

B. When a JMF tolerance applies to a constituent, full tolerance will be given even if it exceeds the control points established in this specification. Full tolerance will be given for RAP content even if it exceeds the limits established in this specification.

C. Take corrective action when the RAP content exceeds the above tolerance. If the RAP content continues to be outside tolerance, stop production until a plan for corrective action is approved by the Engineer.

2.4 TACK COAT

A. Tack coat shall be in accordance with ODOT Section 00730.11, CSS-1 or CSS-1h.

PART 3 - EXECUTION

3.1 TACK COAT

A. Construct in accordance with ODOT Section 00730.

B. Apply at rate between 0.06 and 0.20 gallon per square yard (residual asphalt) at a temperature between 125ºF and 165ºF (emulsified asphalt).

C. Apply between lifts of asphalt concrete base and surface courses when lifts are separated by more than one day.

D. Apply to existing pavement surfaces and structures that will be in contact with new asphalt concrete surface course.

3.2 SMALL QUANTITY ACCEPTANCE

A. The mixture will be accepted by visual inspection by the Contractor. If the mixture is considered suspect, the Contractor may verify that the mixture is within the tolerances and limits of this specification.

3.3 EQUIPMENT

A. Lime-Treated Aggregate Plant: When lime-treated aggregate is selected by the Subcontractor, provide a mixing plant that includes:
   1. Pug Mill: A pug mill that mixes the aggregate and lime until the aggregate is uniformly coated and the lime is distributed throughout the aggregate. Provide a system for adding water to the pug mill if necessary to achieve aggregate that is in SDC. This requirement may be waived by the Contractor if the stockpiled aggregates are watered to the satisfaction of the Contractor.
   2. Lime Metering Device: A lime metering or weighing device that determines the amount of lime incorporated within any selected time period. Provide a device that is of sufficient accuracy to supply lime within the tolerances specified herein.

B. HMAC Mixing Plant: Provide HMAC plants that comply with the following:
   1. Scales: Provide required scales to ensure a uniform mixture. Check and adjust scales according to these specifications.
   2. Vibratory Scalping Devices: Provide vibratory scalping devices ahead of the mixer to reject aggregate, RAP, and lumps of cemented material that are detrimental to the mix.
   3. Asphalt Anti-Strip Additive Metering Device: When asphalt anti-strip additive is added into the asphalt at the HMAC mixing plant, provide a means to weigh or meter the additive at a specified rate that has an accuracy of plus or minus 0.5 percent.
   4. Thermometers: Provide the following:
      a. A direct reading, full operating range thermometer in the asphalt feed line near the mixer unit.
      b. A thermometric instrument that automatically registers the temperature of the materials at the discharge of the mixer.
   5. Sampling Devices: Provide and operate a device that produces a representative sample of the quantity of material required for the appropriate tests when sampling at or around crushing, screening, or mixing plants.
   6. WMAC Mixing Production: Modify the asphalt mixing plant as required by the manufacturer to introduce the WMAC technology. Plant modifications may include additional plant instrumentation, the installation of asphalt binder foaming systems and WMAC additive delivery systems, tuning the plant burner, and adjusting the flights in order to operate at lower production temperatures and reduced tonnage. Document the integration of plant controls and interlocks.

C. Hauling Equipment: Provide hauling vehicles in good operating condition with tight, clean, smooth beds and truck covers, as necessary. Coat the beds with a minimum amount of an approved material to keep the HMAC from sticking to the beds. Do not use diesel fuel or other solvents that may be detrimental to the integrity of the HMAC mixture. Drain excess coating material before loading by raising the truck bed, opening belly dump gates, or operating the conveyor belt, as appropriate.

D. HMAC Pavers: Pavers shall comply with the following:
   1. Power and Support: Self-contained, self-propelled, supported on tracks or wheels, none of which contact the mixture being placed.
   2. Augers and Screed: Equipped with augers and a screed or strike-off assembly, heated if necessary, which:
      a. Can spread and finish the HMAC to a uniform texture, in the specified widths, thicknesses, lines, grades, and cross-sections.
      b. Will not segregate, tear, shove, or gouge the HMAC.
      c. Do not use diesel fuel or other solvent products to prevent sticking that may be detrimental to the integrity of the HMAC mixture.
   3. Control System: Equipped with a paver control system which:
      a. Controls the HMAC placement to specified slope and grade.
      b. Maintains the paver screed in proper position.
      c. Provides the specified results through mechanical sensors and sensor-directed devices actuated from independent line and grade control references.
      d. Illumination: Provide adequate lighting to illuminate the paver and the roadway in front of and behind the paver during the period from 30 minutes after sunset to 30 minutes before sunrise, or as deemed necessary by the Contractor. Provide a minimum light level of 10 foot-candles as measured by the Contractor on the paved surface at a distance of 16 feet from the front and back edges of the paver. Shield lighting from adjacent traffic and roadways as necessary.

E. Rollers:
   1. Use rollers of the vibratory, steel wheel, and pneumatic tired type. They shall be in good condition and capable of operating at slow speeds to avoid displacement of the bituminous mixture. Provide self-propelled rollers capable of reversing without backlash. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.
   2. Vibratory rollers shall operate within the manufacturer's approved range. Do not operate in vibratory mode for lifts thinner than two times the maximum aggregate size for the type of HMAC being compacted. Do not operate in vibratory mode for finish rolling.
   3. Pneumatic-tired rollers shall be fully skirted to reduce tire heat loss and mixture pick-up.
   4. Equipment which causes excessive crushing of the aggregate will not be allowed.
   5. Provide adequate lighting to illuminate each roller and the roadway in front of and behind the roller during the period from 30 minutes after sunset to 30 minutes before sunrise, or as deemed necessary by the Contractor. Provide a minimum light level of 10 foot-candles as measured by the Contractor on the paved surface at a distance of 60 feet from the front and back edges of each roller. Shield lighting from adjacent traffic and as necessary.

3.4 CONSTRUCTION

A. Season and Temperature Limitations: Place HMAC during the dates indicated below, and when the temperature of the surface that is to be paved is not less than the temperature indicated:

Nominal Compacted Thickness of Individual Lifts and Courses as Shown on the Typical Section of the Drawings	All Levels	Level 1 and Level 2	Level 3 and Level 4	
		All Courses	Travel Lane Wearing Course	All Other Courses
	Surface Temperature*	From To Inclusive	From To Inclusive	From To Inclusive
Less than 2 inches	60ºF and rising	All Year**	3/15 9/30	All Year**
2 inches and Greater	40ºF and rising	All Year**	3/15 9/30	All Year**
Temporary	40ºF	All Year**	3/15 9/30	All Year**

* Do not use field burners or other devices to heat the pavement surface to the specified minimum temperature.

** If placing HMAC between March 15 and September 30, temperature requirement may be lowered 5ºF.

B. Pre-Paving Conference: Supervisory personnel of the Subcontractors who will be involved in the paving work shall meet with the Contractor at a mutually agreed time to discuss methods of accomplishing all phases of the paving work.

C. Preparation of Underlying Surfaces:
1. All bases and foundations on which the pavement is to be constructed shall meet the applicable specifications and shall be approved prior to the start of paving. Recondition existing bases and foundations in accordance with Section 31 20 01. Clean existing surfacings of all loose material, dirt and dust by brooming, flushing with water or other approved methods. Sawcut broken or ragged edges to firm material when directed by Contractor.
2. Treat all paved surfaces on and against which HMAC is to be placed with an asphalt tack coat, in accordance with ODOT Section 00730. Immediately before applying the tack coat, clean and dry the surface to be tacked. Remove all material, loose or otherwise, that will reduce adhesion of the tack by brooming, flushing with water, or other approved methods.
3. Level and compact depressed areas with HMAC as specified or directed by the Contractor. Perform the leveling work as a separate operation and at the locations and to the extent shown or directed by the Contractor. Spread the leveling material with a paving machine, unless otherwise directed by the Contractor.
4. Protect all existing structures from the overlay operation and check and clean as necessary after the overlay.
5. The pavement surface shall be dry prior to the preparation work and paving. Remove existing pavement markers, recessed markers, and pavement legends prior to paving. Remove painted pavement legends by hydroblasting, steel shot blasting, or grinding so that the pavement surface is not damaged below a depth of 1/8 inch. Remove durable pavement legends and durable pavement markings by steel shot blasting or grinding to the pavement surface to a depth no greater than 1/8 inch, creating a smooth, flat slot of uniform depth.

D. Drying and Heating Aggregates for HMAC:
   1. Burner Operation: Operate the burner used to heat the aggregates to completely burn the fuel so the aggregate and asphalt are not contaminated and the asphalt is suitably aged.
   2. Heating Temperatures: Establish the allowable mixing and placement temperature ranges determined by the JMF. Measure the mixture temperature at the discharge of the mixer andthe placement temperature behind the paver. The maximum mixture temperature of the HMAC shall not exceed that of the oil supplier's temperature-viscosity curve at the mixer.
      a. The maximum placement temperature for HMAC at the mixer shall be 350ºF.
      b. The minimum placement temperature shall be 240ºF for HMAC behind the paver. The minimum placement temperature shall be 215ºF for WMAC behind the paver.
   3. Within the above limits, the Subcontractor (with the approval of the Contractor) or the Contractor may adjust the temperature in 10ºF increments from the JMF as follows:
      a. Up: If the aggregate coating, moisture content, workability or compaction requirements are not attained.
      b. Down: If the aggregate coating, moisture content, workability and compaction requirements are attained.

E. HMAC Storage: Temporary storage or holding of hot HMAC will be allowed only as approved by the Contractor. If allowed, the Subcontractor shall comply with the following requirements.
   1. Flow Diverter: Provide a device to divert the flow of HMAC away from the silo when starting or stopping plant production, or at any other time necessary, so improperly proportioned mixture or incompletely mixed portions of the mixture do not enter the silo.
   2. Batcher: Equip storage silos with a batcher, rotating chute, or similar device to prevent segregation of HMAC as it enters the silo.
   3. Unheated Silos: Store HMAC in unheated silos only when the total elapsed time from the mixing to the placing is less than six hours.
   4. Heated Silos: Store HMAC in heated, insulated silos no more than 72 hours only if an atmosphere is maintained in the silo at all times which prevents damage to the mixture or asphalt properties.
   5. Discharging AC and Loading Trucks: Discharge the HMAC and load trucks so segregation is prevented. If the HMAC is segregated, dispose of segregated HMAC and stop temporary storage of the HMAC.

3.5 CONTROL OF LINE AND GRADE

A. Use a floating beam device of adequate length and sensitivity to control the grade of the paver. Where this method is impractical, manual control of the grade will be allowed when approved by the Contractor.

B. Establish references at reasonable intervals for line and grade control of placement operations for the following:
   1. Before placing each leveling lift.
   2. Before placing the top base course for new construction.

C. Line and grade for the top base course of new construction and top leveling lift shall be within 1/2 inch of design line and grade.

3.6 HAULING, DEPOSITING, AND PLACING

A. Haul, deposit, and place HMAC as follows:
   1. Hauling: Cover HMAC if rain or cold air temperatures are encountered any time between loading and placement.
   2. HMAC will be rejected before placing if one or more of the following is found:
      a. Below specified placing temperature limit.
      b. Slumping or separating.
      c. Solidifying or crusting.
      d. Absorbing moisture.
      e. Oil slicks.
   3. Deliver the mixture to the paving machine at a rate that provides continuous operation of the paving machine, except for unavoidable delay or breakdown. If excessive stopping of the paving machine occurs during paving operations, the Contractor may suspend paving operations until the mixture delivery rate matches the paving machine operation. Any HMAC mixture placed under these circumstances will be subject to rejection based on limits found in these specifications.
   4. Remove, dispose of, and replace rejected HMAC.

B. Depositing: Deposit HMAC from the hauling vehicles so segregation is prevented. When HMAC is windrowed, the pick-up equipment shall:
   1. Substantially pick up all of the HMAC deposited on the roadway.
   2. Be self-supporting, not exerting any vertical load on the paving machine, nor causing vibrations or other motions which could have a harmful effect on the riding quality of the completed pavement.

C. Placing: Alternative equipment and means may be allowed by the Contractor if the use of a paver is impractical.
   1. Do not place HMAC during rain or other adverse weather conditions, unless allowed by the Contractor. HMAC in transit at the time adverse conditions occur may be placed if:
      a. It has been covered during transit.
      b. The HMAC temperature is satisfactory.
      c. It is placed on a foundation free from pools or flow of water.
      d. All other requirements are met.
   2. When leveling irregular surfaces and raising low areas, do not exceed 2 inches actual compacted thickness of any one lift, except the actual compacted thickness of intermittent areas of 1,000 square feet or less may exceed 2 inches, but not more than 4 inches. This may require portions of the mixture to be laid in two or more lifts.
   3. Place the mixture in the number of lifts and courses, and to the compacted thickness for each lift and course, as shown. Place each course in one lift unless otherwise specified. Do not exceed a compacted thickness of 4 inches for any lift. Limit the minimum lift thickness to twice the maximum aggregate size in the mix.
   4. Do not intermingle HMAC produced from more than one JMF. Each base course panel placed during a working shift shall conform to a single JMF. The wearing course shall conform to a single JMF, except for adjustments in the JMF according to this specification.

3.7 COMPACTION (SMALL QUANTITIES)

A. Obtain the Contractor's acceptance of the base course prior to beginning construction of the asphalt concrete wearing course.

B. Compact the mixture thoroughly and uniformly to a minimum density of 91 percent for the base course and 92 percent for the wearing course of the MDT. Each MDT will be determined using the Gmm determined in accordance with AASHTO T 209, for the particular mix being used.

3.8 LONGITUDINAL JOINTS

A. Drop Offs:
   1. Provide warning signs and markings where abrupt or sloped edge drop-offs 1 inch or more in height occur.
   2. Protect edges from being broken down.
   3. If unable to complete the pavement under traffic without drop-offs, do the following:
      a. Construct and maintain a wedge of HMAC at a slope of 1V:10H or flatter along the exposed longitudinal joint.
      b. Remove and dispose of the wedge before continuing paving operations.
      c. Construct, maintain, remove, and dispose of the temporary wedge.

B. Placing HMAC Under Traffic: When placing HMAC pavement under traffic, schedule work for the nominal thickness being laid as follows:
   1. More than 2 Inches: Schedule work so that at the end of each working shift the full width of the area being paved, including shoulders, is completed to the same elevation with no longitudinal drop-offs.
   2. Less than or Equal to 2 Inches: Schedule work so that at the end of each working shift one panel of new travel lane pavement does not extend beyond the adjoining panel of new travel lane pavement more than the distance normally covered by each shift. At the end of each workweek complete the full width of the area to be paved, including shoulders, to the same elevation with no longitudinal drop-offs.

3.9 TRANSVERSE JOINTS

A. Travel Lanes: Construct transverse joints on the travel lane portion of all specified pavement courses, except leveling courses, as follows:
   1. Temporary End Panel:
      a. Maintain pavement depth, line and grade at least 4 feet beyond the selected transverse joint location, and from that point, wedge down on the appropriate slope until the top of the course being laid meets the underlying surface (assuming a pavement course thickness of 2 inches) as follows:
         1) For wedges that will be under traffic for less than 24 hours, construct an 8 foot long wedge (1V:50H taper rate).
         2) For wedges that will be under traffic for 24 hours or longer, construct a 25 foot long wedge (1V:160H taper rate).
         3) Construct, maintain, remove, and dispose of the temporary wedge . HMAC for the temporary wedge would be paid for at the pay item price.

b. When the pavement course thickness is different than the above 2 inch example, use the appropriate taper rate to compute the length of the wedge. The wedge length plus the 4 feet or longer panel form the "temporary end panel."

2. Vertical Face: After the mixture has reached the required density:
   a. Provide a smooth, vertical face the full depth of the course being laid at the location selected for the joint by sawing, butting, or other approved method.
   b. Remove the HMAC material from the joint to the end of the panel. If removed before resuming paving beyond the joint, reconstruct the temporary end panel immediately by placing a bond-breaker of paper, dust, or other suitable material against the vertical face and on the surface to be occupied by the temporary end panel. Construct a full-depth temporary end panel at least 4 feet long, beginning at the sawed or cut joint, and taper it as specified.
3. Excess HMAC: After completing a temporary end panel as specified, dispose of unused, remaining HMAC.
4. Resume Paving: When permanent paving resumes, remove the temporary end panel and any bond-breakers. Clean the surface of all debris and apply a tack coat to the vertical edge and the surface to be paved.
5. Joint Requirements: Compact both sides of the joint to the specified density. When tested with a straightedge placed across the joint, the joint surface shall conform to the specified surface tolerances.

3.10 TEMPORARY SURFACING

A. Provide HMAC for temporary surfacing that is a well-graded, uniform, durable commercial mix. All new materials, or a combination of new materials and reclaimed materials, may be used. The Subcontractor is responsible for the quality of the material furnished and for maintaining the surface in a condition appropriate for the facility.

3.11 ACCEPTANCE OF LINE AND GRADE

A. The finished top of any base course when tested with a Subcontractor-furnished 16-foot straightedge shall not vary from the testing edge by more than 3/8 inch at any point, and shall be within 1/2 inch of specified finished grade.

B. The finished top of the surface course when tested with a Subcontractor-furnished 16-foot straightedge shall not vary from the testing edge by more than 1/4 inch at any point, and shall be within 1/2 inch of specified finished grade.

C. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

D. Correction of Pavement Roughness: Immediately correct equipment or paving operation procedures when tests show the pavement smoothness does not comply with these specifications. In addition, do the following:
   1. Correct surface roughness to the required tolerances, using one of the following methods as approved by the Contractor:
      a. Base Course:
         1) Profile to a maximum depth of 0.4 inch with abrasive grinder(s) equipped with a cutting head comprised of multiple diamond blades.

2) Remove and replace the base lift.

b. Wearing Course:

1) Remove and replace the wearing surface lift.

2) Profile to a maximum depth of 0.3 inch with abrasive grinder(s) equipped with a cutting head comprised of multiple diamond blades and apply an emulsified asphalt fog coat as directed.

2. Complete correction of all surface roughness within 14 days following notification, unless otherwise directed by the Contractor.

3.12 CORRECTION OF DEFECTS

A. Correct all defects in materials and work as follows:

1. Fouled Surfaces: Immediately repair, clean, and re-tack fouled surfaces that would prevent full bond between successive lifts of mixture.
2. Boils, Slicks, and Oversized Material: Immediately remove and replace boils, slicks, and oversized materials with fresh mixture.
3. Segregation: Take immediate corrective measures when segregation or non-uniform surface texture is occurring in the finished mat. If segregation continues to occur, stop production until a plan for providing uniform surface texture is approved by the Contractor.
4. Roller Damage to the Surface: Immediately correct surface damage from rollers with additional fresh mixture or by other means approved by the Contractor.
5. Longitudinal Joints: Take immediate corrective measures when open longitudinal joints are being constructed or when the elevation of the two sides of a longitudinal joint does not match. If problems with the longitudinal joint continue to occur, stop production until a plan for providing tight, equal elevation longitudinal joints is approved by the Contractor.
6. Corrective Measures: Take immediate corrective measures when the specified compaction density is not being achieved.
7. Other Defects: Remove and replace any HMAC that:
   a. Is loose, broken, or mixed with dirt.
   b. Visually shows too much or too little asphalt.
   c. Is defective in any way.

3.13 TRAFFIC

A. Vehicular traffic, including heavy equipment, is not allowed on newly paved areas until surface temperatures have cooled to at least 120ºF. Measure surface temperatures by approved surface thermometers.

END OF SECTION 32 12 00

SECTION 32 16 13 - CONCRETE CURBS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes construction of cast-in-place curbing.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00, Cast-In-Place Concrete

B. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

PART 2 - PRODUCTS

2.1 CONCRETE

A. Cast-In-Place Concrete Curbing: Curbing shall conform to the requirements of Section 03 30 00.

2.2 EXPANSION MATERIAL

A. Premolded, nonextruding filler material, 1/2-inch minimum thickness.

2.3 ADHESIVE - EXTRUDED CURB

A. Bonding agent shall be an epoxy resin, Concresive No. 1064, or equal.

2.4 CURING COMPOUND

A. See Section 03 30 00, Cast-in-Place Concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cast-In-Place Concrete: Compact subgrade to the requirements of Section 31 20 01, Site Preparation and Earthwork – Fuel Systems. Immediately prior to placing the concrete, wet the subgrade thoroughly to prevent moisture loss from the concrete mix to the subgrade.

B. Extruded Concrete: Prior to placing curbing, clean the existing surface and apply bonding agent to the entire contact surface.

3.2 JOINTS

A. Cast-In-Place Concrete: Construct contraction joints of the weakened-plane type between expansion joints at intervals of no more than 10 feet unless otherwise shown on the drawings. Form the contraction joints by grooving and inserting a preformed bituminous filler, or by other approved means. The top width of the joints shall not be less than 1/8 inch or greater than 1/4 inch. The joints shall penetrate 2 inches into the face and top surface of the curb.

B. Extruded Concrete: Construct saw joints every 20 feet.

C. Driveways: Construct in accordance with the drawings.

3.3 PLACEMENT AND FINISHING

A. The concrete forms, if of wood, shall be sprayed, oiled, or otherwise covered with an impermeable membrane before use.

B. Remove forms after the concrete has taken its initial set and while the concrete is still green. Repair minor defects with mortar containing one part portland cement and two parts sand. Plastering will not be permitted on the faces and exposed surfaces. Honeycombed and other structurally defective concrete shall be removed and replaced. While the concrete is still green, the exposed surfaces shall be finished by rubbing down high spots and form marks, by rubbing the moistened surfaces with a suitable device to provide a uniform texture and smooth surface, or by applying and rubbing a thin cement grout to produce a uniform color.

C. Broom-finish driveways with strokes at right angles to length. Smoothly finish edges with an edging tool, and be free of broom marks.

D. Cast-in-place curb top and the 10 inches of curb face shall be steel-trowelled and “broom” finished with a fine haired broom parallel to the direction of the curb.

E. After finishing has been completed, cover the concrete with an impermeable membrane, or keep continuously wet, until the concrete has reached a compressive strength of at least 2500 psi.

F. Protect and cure surfaces from which forms are removed before the curing period has elapsed as specified for surfaces not covered by forms.

3.4 CURING AND PROTECTION - DRIVEWAYS

A. Apply curing compound to exposed surfaces immediately after finishing.

B. Apply in sufficient quantity to obscure natural color of the concrete.

3.5 CONSTRUCTION ADJACENT TO CURB

A. No base rock shall be placed above the bottom of the curb until the concrete has reached a compressive strength of at least 2500 psi. Curbs shall be properly backfilled before base aggregate is placed and compacted.

B. After completion of the paving, repair chips and gouges in the exposed portion of the curb. For patching, use cement mortar containing one part portland cement and two parts sand.

3.6 TOLERANCES

A. The finished surfaces shall be within 1/4 inch, plus or minus, of finish grade and alignment. The exposed surfaces shall be brush-finished and free of spalls, holes, rock pockets or honeycomb and shall present a smooth, clean and neat appearance.

END OF SECTION 32 16 13

SECTION 32 16 15 - CONCRETE SIDEWALK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes construction of cast-in-place concrete sidewalk.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00, Cast-In-Place Concrete

B. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

PART 2 - PRODUCTS

2.1 CONCRETE

A. Concrete shall conform to the requirements of Section 03 30 00.

2.2 EXPANSION MATERIAL

A. Premolded, nonextruding filler material, 1/2-inch minimum thickness.

2.3 CURING COMPOUND

A. See Section 03 30 00, Cast-in-Place Concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Compact the subgrade as specified in Section 31 20 01, Site Preparation and Earthwork – Fuel Systems. Immediately prior to placing the concrete, thoroughly wet the subgrade to prevent moisture loss from the concrete mix to the subgrade.

3.2 JOINTS

A. Construct in accordance with the drawings.

3.3 PLACEMENT AND FINISHING

A. The concrete forms, if of wood, shall be sprayed, oiled or otherwise covered with an impermeable membrane before use.

B. Forms shall be removed after the concrete has taken its initial set and while the concrete is still green. Minor defects shall be repaired with mortar containing one part portland cement and two parts sand. Plastering will not be permitted on the faces and exposed surfaces. Honeycombed and other structurally defective concrete shall be removed and replaced at no added cost to the Contractor.

C. Surface of sidewalk shall be “broom” finished with strokes at right angles to length. Edges shall be smoothly finished with an edging tool and be free of broom marks.

D. Surfaces from which forms are removed before the curing period has elapsed shall be protected and cured as specified for surfaces not covered by forms.

3.4 CURING AND PROTECTION

A. Apply curing compound to exposed surfaces immediately after finishing. Apply in sufficient quantity to obscure natural color of the concrete.

B. After finishing has been completed, cover the concrete with an impermeable membrane or keep continuously wet until the concrete has reached a compressive strength of at least 2500 psi.

3.5 TOLERANCES

A. The finished sidewalk shall be within 1/4 inch, plus or minus, of finish grade and alignment when tested with a 10-foot straightedge.

END OF SECTION 32 16 15

SECTION 32 31 13 - CHAIN-LINK FENCES AND GATES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the construction of new chain-link fence and gates.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00, Cast-in-Place Concrete, for fence and gate post foundations.

B. Section 32 31 14, Automatic Gate Operator and Control, for the gate operator installation related to the fence revisions and cantilever gate work specified in this section.

1.3 REFERENCES

A. ASTM: American Society for Testing and Materials
   1. ASTM A121: Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
   2. ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   3. ASTM A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
   4. ASTM A392: Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
   5. ASTM F1043: Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
   6. ASTM F1083: Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
   7. ASTM F2329: Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

1.4 SUBMITTALS

A. Product Data: Submit product data for fabric, posts, gates, accessories, fittings, and hardware.

B. Manufacturer’s Installation Instructions: Submit manufacturer’s installation instructions and any required anchor bolt templates.

PART 2 - PRODUCTS

2.1 GENERAL

A. Galvanizing shall conform to the following specifications:
   1. Posts, rails, appurtenances - ASTM F1083, ASTM A121, ASTM A123, ASTM A153, or ASTM F2329, as applicable.
   2. Fabric - ASTM A392, Class 1.

B. SS40 materials shall conform to the following specifications:
   1. Posts, rails, and braces ASTM F1043, Group IC; external coatings per F1043, Type B; internal coatings per F1043, Type D.
   2. Manufacturer shall be Allied Tube and Conduit, or equal.

2.2 FABRIC

A. Plain:
   1. Continuous chain-link, 2-inch-square mesh, 7-foot height unless shown otherwise on the drawings.
   2. 9-gauge carbon steel wire.
   3. Hot-dip galvanized at a rate of not less than 1.2 ounces of zinc per square foot of uncoated surface.
   4. Selvage twisted and barbed, top and bottom.

2.3 POSTS, RAILS, AND BRACES

A. General: Line, terminal (end, corner, pull and brace posts), top rails, braces, gate posts, and all appurtenances shall be hot-dip galvanized carbon steel or SS40. Minimum size and weight shall be not less than specified.

B. Line posts shall be one of the following:
   1. Type I, round post, 2.375 inches O.D., 3.65 pounds per linear foot.
   2. Roll formed section, 2.25 inches by 1.70 inches, 2.64 pounds per linear foot.

C. Terminal posts (end, corner, and pull posts) shall be one of the following:
   1. Type I, round post, 2.875 inches O.D., 5.79 pounds per linear foot.
   2. Roll-formed section, 3.50 inches by 3.50 inches, 4.85 pounds per linear foot.

D. Gate Posts: Size as shown on the drawings.

E. Top Rail and Braces:
   1. Shall be one of the following:
      a. Type I, pipe, 1.66 inches O.D., 2.27 pounds per linear foot.
      b. Roll-formed section, 1.625 inches by 1.25 inches, 1.35 pounds per linear foot.
   2. Rail lengths shall be not less than 18 feet.
   3. Rail couplings shall be pressed steel or malleable iron sleeves, 7 inches long with .07-inch, minimum, wall thickness.

4. Truss rod, 3/8-inch diameter, with adjustable takeup (for diagonal truss).

F. Barbed Wire: Two-strand 12 1/2-gauge wire with 14-gauge, 4-point barbs, 5 inches apart. Zinc coating shall be Class 3.

G. Fabric Ties: 6-gauge steel clips for rolled form section posts. Minimum 9-gauge steel or aluminum wire for round posts.

H. Tension Wire: 7-gauge heavy-galvanized high-carbon steel.

I. Tension Bar: 3/16 inch by 3/4 inch, minimum, 2 inches less than full height of fabric.

J. Post Tops and Extensions:
1. Posts shall be fitted with galvanized heavy malleable iron or pressed steel tops. Bases of the post tops shall have flanges which fit around the outside of the top of the posts. Tops for pipe section posts shall be dome or round shaped, fitting over the top of the post to exclude moisture.
2. Where the fence fabric is to be surmounted with three or more strands of barbed wire, posts shall be equipped with extension arms or brackets for supporting the barbed wire in the position shown on the drawings. The supporting arms or brackets shall be galvanized.

2.4 GATES

A. Frames:
1. Hot-dip galvanized carbon steel pipe or SS40.
2. 1.875 inches O.D., 2.72 pounds per linear foot, minimum.
3. Bracing - 1.625 inches, 2.27 pounds per linear foot, minimum, verticals with 3/8-inch truss rods for cross bracing.
4. Connections shall be either welded or constructed using galvanized pressed steel corner fittings. If connections are welded, apply “Galralloy,” or equal, to all properly prepared welded connections.

B. Hinges - Swinging Gates:
1. Ball-and-socket type allowing gate to swing back to fence.
2. High grade galvanized malleable iron, clamped in place.
3. Lower hinge adequate to support entire vertical load and provide for resultant horizontal reaction with no twisting.

C. Latches:
1. General:
   a. Positive, galvanized malleable iron latch with provisions for padlock.
   b. Latches, clasps, and bolts accessible from either side of gate.
2. Swinging Gate:
   a. Provide plunger-bar-type latches, full-gate height engaging gate stop.
   b. Provide stops or flush plate with anchor set in concrete, and arranged to engage plunger bar of latch.
   c. Arrange keepers to support and secure free end of gate in full open position.

D. Fittings: Hot-dip galvanized malleable cast iron or pressed steel.

E. Fabric and barbed wire as specified for fence.

F. Gate Support Tracks: Sliding gate tracks shall be 1 5/8 inches O.D., 2.27-pounds-per-linear-foot pipe. Two tracks with steel roller bearing wheels shall be provided with each gate.

G. Angle Track: Provide angle track and wheel as shown on the drawings for opening end of each sliding gate.

H. Safety Post - Sliding Gates: 2.375 inches O.D., 3.65 pounds per linear foot.

2.5 CONCRETE

A. 2,500 psi minimum, as specified in Division 03.

PART 3 - EXECUTION

3.1 EXISTING FENCE REMOVAL AND REUSE

A. Roll fabric and barbed wire carefully without damaging. Use 30-inch, maximum, roll diameter.

B. In pavement areas to remain, cut off posts at ground level. Grind flush with pavement surface and fill post with concrete. Pull posts and footings in all other areas. Backfill holes with material matching adjacent.

C. Store fabric and barbed wire in a manner that will prevent damage. Deliver to location shown on the drawings.

D. Posts removed shall become the property of the Subcontractor and shall be removed from Port property.

E. Install salvaged fabric as specified for new fencing using salvaged fittings when in acceptable condition.

3.2 POSTS

A. Space 10 feet O.C., maximum.

B. Check for vertical and top alignment.

C. Secure in place during placement and finishing operations.

D. Hole diameter shall be 12 inches, minimum. Install as shown on the drawings.

E. Set posts to a minimum of 36 inches below surface. Deeper excavation shall be required for soft or loose soil, and for posts with heavy lateral loads.

F. Place concrete around posts in a continuous pour and tamp for consolidation.

G. Trowel finish tops of footings, and slope or dome to direct water away from posts.

H. Extend footings to underside of bottom hinges.

I. Set keepers, stops, sleeves and other accessories into concrete as required.

3.3 TOP RAIL

A. Install top rail with clamps to end, corner, or gate posts.

B. Join sections with sleeve couplings.

C. Install an expansion coupling at 100-foot intervals, maximum.

3.4 BRACES

A. Brace all terminal (end, corner, gate and pull) posts.

B. Space midway between top and ground.

C. Fasten securely with clamps.

D. Extend trusses from terminal posts to brace posts.

E. Fasten truss rods and tighten.

F. Consider changes in direction 30 degrees or more a corner.

3.5 FABRIC

A. Install fabric on outside of fence as directed.

B. Install bottom selvage 2 inches, maximum, above ground.

C. Cut each span of fabric and attach independently at terminal posts, with stretcher bars and fabric bands at 15-inch intervals, maximum.

D. Pull taut before fastening to posts, rails, and tension wires so fabric will remain in tension.

E. Fasten to line posts with tie wire, metal bands, or by an approved method, at 15-inch intervals, maximum.

F. Fasten top edge to top rail or top tension wire with tie wires at 24-inch intervals, maximum.

G. Join rolls of fabric by weaving a single strand into ends of the rolls to form a continuous mesh.

H. Fasten bottom edge to bottom tension wire with wire ties at 24-inch intervals, maximum.

3.6 GATES

A. Attach fabric the same as for fence.

B. Attach hinges, latch, and keeper with rivets or other means.

C. Install gates plumb, level, and secure for full width opening without interference.

D. Install ground set items in concrete for anchorage.

E. Gaps between gates, between gate to ground, and between gate to gate post or fence post shall be no greater than 4 inches. Preferred gap space is 2 to 4 inches.

F. Adjust hardware for smooth operation and lubricate where necessary.

G. All gates shall have lockable mechanisms.

H. 4-foot gates shall have hinges securely riveted to prevent any rotation of gate.

I. Equip opening end of all sliding gates with two 8-inch rubber-tired wheels on 5/8-inch axle. Wheel spacing shall be 22 inches center-to-center.

J. Provide braces from each side of the wheel assembly to a point approximately 12 inches above the bottom of the gate frame.

K. Provide intermediate supports on all sliding gates. Attach 3/8-inch truss rods between top and bottom of all vertical supports. Supports shall be 1.625 inches O.D., 1.35 pounds per linear foot, spaced 5 feet O.C.

END OF SECTION 32 31 13

SECTION 32 31 14 - AUTOMATIC GATE OPERATOR AND CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes requirements unique to the installation of the controls and operator for the chain link fence sliding cantilever gate.

B. Because certain of the control details will be dependent on the materials and equipment offered, circuitry and layouts shown on the drawings shall be considered typical only.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 32 31 13, Chain-Link Fences and Gates, for the fence revisions and cantilever gate work related to the gate operator installation specified in this division.

B. Section 28 10 00, Access Control System, for access control equipment for using card reader and credential to send signal to gate operator to open gate.

1.3 REFERENCES

A. ASTM: American Society for Testing and Materials
   1. ASTM D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))

1.4 SUBMITTAL REQUIREMENTS

A. Submit a pre-design narrative of anticipated system design which shall include: Proposed connection to existing Portland International Airport security access system and types of security access components.

B. Submit shop drawings of system design. Shop drawings shall be new, prepared by the Subcontractor using CAD and backgrounds of the contract drawings, with title blocks, identifying drawing number and any reference drawings. Fully dimension all plans and elevations.
   1. Shop drawings shall show any changes to the contract drawings and shall include new control drawings as necessary.
   2. Card Access Control System: Refer to Division 28 specifications for submittals.

C. Submit certification of UL label and listing of other testing agencies.

D. Submit operation and maintenance manuals.

E. Submit complete technical data with catalog information for the following:
   1. Battery backup system.
   2. Gate operator.

3. Control cabinet.
4. Loop detectors.
5. Meter base.
6. Programmable logic controller including power supply, I/O racks, I/O cards.
7. Flashing light/buzzer.
8. Panelboard.
9. Circuit breakers.
10. Keyless entry device.
11. Traffic detector loops.

F. The Engineer may request submittals on additional information as needed.

1.5 GATE OPERATION

A. The operation of the gate shall be as follows:
   1. Access from the outside of the secure area, through the gate, into the secure apron area shall be controlled by the specified keyless operator, card reader, or by remote radio control.
      a. The gate shall not allow access unless a vehicle is present over the security loop.
      b. After the code is entered into the keyless control unit,
         1) the correct code is entered into the card reader,
         2) or the remote transmitter is depressed,
         3) the gate will open.
      c. The gate will remain open as long as vehicle presence is sensed by the loop detector.
      d. If no vehicle crosses the "close" loops within a preset adjustable time (up to 30 seconds) after the gate opens, the gate will automatically close if vehicle presence is not detected.
      e. After the gate starts to close, sensing of a vehicle on the "close" loop will again open the gate.
      f. After the gate closes, sensing of a vehicle on the outside loop will not reopen the gate unless the process is repeated.
   2. Access from the inside of the secure area, through the gate, to the outside, shall be a free exit.
      a. "Close" Loop "A" senses the vehicle before "Close" Loop "B" and the gate opens.
      b. The gate opens and remains open so long as either loop senses the vehicle or a preset adjustable time expires.
      c. After the gate starts to close, sensing of a vehicle on either loop will again open the gate.

B. The Subcontractor shall provide all raceways and wiring required for power and control wiring.

PART 2 - PRODUCTS

2.1 GATE OPERATOR

A. Shall be minimum 1 hp. Input voltage shall be 208 volt, 3 phase; hinged to open left or right as indicated on the drawings.

B. Shall be industrial duty, steel base and frame enclosed in a weather resistant lockable enclosure. Include mounting for poured-in-place concrete base. Drive equipment shall be housed to prevent tampering and to protect personnel and public from injury.

C. Drive Unit:
   1. Use worm gear in oil-bath gear reducer for primary speed reduction. Final drive shall use No. 50 roller chain.
   2. Provide with an adjustable torque limiter and solenoid-actuated disc-type brake.
   3. Adjustable limited switches shall be of the driven type and the limit settings shall not be affected by removal of the motor.
   4. Motor shall be totally enclosed and shall be a high-starting torque, continuous duty industrial type, protected against overload.
   5. Provide with means, accessible only to authorized personnel, to open and close gate manually without power.
   6. Provide with enclosed On/Off power switch for servicing. Provide a left/right reversing switch to allow use of the operator for both right-hand and left-hand sliding gates with no additional circuit modifications.

D. Control voltage shall be 24 volt, 60 Hz and control functions shall be contact “Open,” “Close,” and “Stop.”

E. LiftMaster SL 580 or pre-bid approved equal, 3-phase, with the following options:
   1. Time delay to close.
   2. Reversing delay.
   3. Capability for safety reversing device.

F. Gate control shall be electric.
   1. Components for gate travel and limit control shall be in the gate operator housing.
   2. Control leads for gate opening and gate closing shall be extended to control logic in a remote gate control cabinet.
   3. Electrical components shall be UL component labeled; and in the absence of a UL assembly listing, shall be locally wired by Oregon-licensed personnel. The wired operator shall be acceptable to the City of Portland Electrical Division.

G. Cabinet housing.
   1. Raintight when closed.
   2. Securely lockable with Port padlock.
   3. Lift-off cover to facilitate access to components.

2.2 RACEWAYS

A. Raceways shall be galvanized rigid steel conduit (GRSC) threaded at each connection (unless non-threaded fittings are approved on a case-by-case basis). Factory threads shall be fully coated.

B. Top and side entries of weatherproof enclosures shall be the Myers type hub.

C. Locknuts for bottom entry of enclosure shall be sealing type. Midwest Type SL, or equal.

D. Bushings shall be insulated-throat grounding type. Midwest Type GLL, or equal.

2.3 CONTROL CABINET

A. 60 inches wide, 62 inches high, 12 inches deep, single-hinged, double-door, floor-standing, padlockable door, NEMA 4 enclosure suitable for outdoor use with internal mounting panel. Hoffman Catalog No. A62H60DLP with back panel No. A60P60, B-Line Catalog No. 626012-4SFD with back panel AW6060P, or pre-bid approved equal.

B. Minimum 14-gauge steel with moisture resistant finish inside and out.

C. Provide one 12-inch-high floor stand kit per cabinet.

D. Provide two 1-inch-diameter breathers with screen inserts in the bottom.

E. Enclosure shall include a heater and circulation fan.

2.4 CONTROL TRANSFORMER

A. A 500 volt-ampere minimum, 120 volt primary to 24 volt secondary. The secondary shall be protected by an FNM-3 cartridge type fuse. Mount in terminal cabinet.

2.5 TERMINAL BLOCKS - GATE OPERATOR CONTROL

A. The terminal blocks shall be of the barrier type, rated minimum 300 volt and minimum 15 amps, pressure plate or solderless box lug type terminals. Provide 10 percent additional spare terminal blocks.

B. Wiring channels for terminal blocks shall be PVC plastic wiring duct, slotted wall with snap-on covers, Panduit Type Ne Series, or equal.

2.6 RECEPTACLE

A. NEMA 5-20R duplex receptacle in a standard 4-inch square by 1 1/2 inch box with raised industrial metal cover.

2.7 GROUND ROD

A. The ground rod shall be a 3/4-inch-diameter, 10-foot-long copper clad rod extending 3 inches above the slab with a No. 6 bonding conductor firmly bonded to the control cabinet enclosure.

B. The ground rod shall be connected by either:
1. Burndy "Hyground Compression System, or equal.
2. Exothermic end-weld method.

2.8 LOOP DETECTOR, VEHICLE SENSING

A. A complete unit which will, in conjunction with an external loop buried in a roadway, sense the presence of a vehicle.

B. A 120 volt a.c., 60 Hz, input. Output shall be the operation of two 2PDT relays.

C. PEEK-Sarasota 535B-MS, or pre-bid approved equal.

2.9 KEYLESS DIGITAL ENTRY DEVICE

A. Refer to Division 28 Specifications.

2.10 RELAY

A. "MCR," "Close," "Open," and "Brake" relays shall be 2P2T, 120-volt, 8-pin, Cuttler-Hammer D5PR2A, or equal.

2.11 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. PLC shall be Allen-Bradley SLC 5/01, Allen Bradley Micrologix 1200, no substitutions. PLC shall be provided complete with power supply, mounting rack, programming software, and programming cables. The minimum number of input/outputs is shown on the drawings.

2.12 MOTOR SPEED CONTROLLER

A. Motor speed controller shall be Allen-Bradley speed controller, Model No. 1305-AA-12A, dual input capability for 240-volt, 1-phase/208-volt, 3-phase input, 208 volt, 3-phase output, rated for 3 hp minimum, no substitutions.

2.13 FLASHING LIGHT/BUZZER

A. Light and buzzer shall be Adaptalight, catalog No. 101BS-N5 or equal, stackable base unit complete with flashing amber buzzer, or equal.

2.14 PUSHBUTTONS

A. Three heavy-duty push buttons are required, mounted in the cabinet. Provide with legend plates reading “Open,” “Stop,” and “Close.”

2.15 PANEL

A. A 120/240 volt, service rated, single phase, 3 wire, 12 space, 60 amp 2P main, solid neutral in a NEMA 1 enclosure. Square D Q0412-24/Q0C12S, or equal. Provide with following 10,000 AIC circuit breakers: One Q0115, one Q0120, and one Q0315. Provide blanks for unused openings.

2.16 CIRCUIT BREAKERS

A. Circuit breakers shall be din rail mountable. They shall be rated 10,000 AIC.

2.17 RADIO CONTROL

A. Transmitter shall be Stanley, two-button, Model 1050, part No. 041-010303-00, or pre-bid approved equal.

B. Receiver shall be Stanley, Model 2032, similar No. 040-009-353-00R, or pre-bid approved equal.

2.18 CARD ACCESS CONTROL EQUIPMENT

2.19 Refer to Division 28 Specifications. USLOT EPOXY

A. Slot filler material shall be a two-part, field-mixed epoxy, Concresive No. 1064, or Fosroc Co. “Gold Label Flex” (distributed by Masons Supply Company of Portland, Oregon), or equal.

2.20 CONDUIT SEALER

A. Material for plugging lead conduits shall be an electrical sealing putty, “Duxseal,” or equal.

2.21 TRAFFIC DETECTOR LOOPS

A. Traffic detector loops shall have:
   1. A minimum of 5 turns. Coordinate with the loop detector manufacturer to ensure loop has sufficient turns to work with the approved loop detector.
   2. Tees at junctions constructed of Schedule 80 CVPC.
   3. Lead-ins twisted four times per foot, minimum.
   4. Wire, 14 AWG, stranded, XHHW, single conductor.
   5. Wires continuous through the loop (no splices).

B. All loops shall be tested three ways: resistance to ground, resistance, and inductance. Submit readings.

2.22 CONCRETE

A. See Division 3.

PART 3 - EXECUTION

3.1 TRENCHING

A. Trenches for direct-buried steel duct may be excavated manually or with mechanical trenching equipment, except manual trenching is mandatory in those areas where existing cables or other utilities may be damaged. The Subcontractor shall be responsible for calling location services.

B. Take care to avoid unnecessary damage to existing asphalt surfaces, i.e., wooden pads shall be placed under the outrigger feet on all trenching or lifting equipment. Repair damage to existing surfaces or equipment at no added cost to the Contractor.

C. Trenches shall be no wider and no deeper than required to meet the minimum depths specified. Where indicated, trenches shall be straight. Trench walls shall be essentially vertical so that a minimum of shoulder surface is disturbed. The bottom surface of the trenches shall be essentially smooth and free of coarse aggregate.

D. Backfill compaction shall be 92 percent of ASTM D1557. Regrade disturbed areas and patch pavement to original condition.

E. Lay out underground conduits to avoid routings which might interfere with the operation or sensitivity of the detector loops. Conduit layouts on the drawings are diagrammatic; give careful consideration to auger diameters required for fence posts and bollards.

3.2 RACEWAYS

A. GRSC conduits shall be clean, smooth, free of sharp edges or burrs, and made up tight to assure water tightness and ground continuity. All fittings shall be approved for the purpose.

B. Underground Conduit:
   1. Minimum depth for electrical conduits shall be 24 inches below finished grades. Minimum 6-inch sand backfill around conduit.
   2. Use 20 mil “3M” #51 tape to cover wrench marks, fieldcuts, couplings, or abrasions that may break outer factory-installed anti-corrosion covering for all metal raceways and couplings that are in contact with the earth or fill materials. All joints shall be threaded and tight with no threads showing.

C. All conduit connections to boxes and cabinets shall be made up with locknuts both outside and inside the box. Bushings shall not be used to lock conduit to box. All openings shall be bushed.

D. Location of conduits, both new and existing, as shown on the drawings are approximate. Field adjustments of those dimensions and the actual riser locations may be necessary as determined by equipment supplied, manufacturer's recommendations, and field conditions.

3.3 GATE OPERATOR INSTALLATION

A. The gate operator shall be positioned and installed per the manufacturer's instructions on a concrete base foundation. Slope to drain, float finish and edge.

B. Location relative to the gate is important, take care to meet the gate operator manufacturer's requirements.

C. Modify the starter supplied as necessary to meet the control functions shown on the drawings.

D. Install chain on the gate, connect the operator chain drive to the chain, and make all adjustments necessary to provide proper gate operation.

E. Set the TEKPAC timer for the gate travel time plus 5 seconds.

F. Set TR time delay for 10 seconds after vehicle has cleared the second loop.

G. Adjust clutch per manufacturer's recommendations.

3.4 CONTROL CABINET INSTALLATION

A. Construct form for bases and after conduits are positioned, pour concrete base (around conduits) for the new control cabinet. Insert anchors for the cabinet legs or stainless steel insert anchors after concrete cures. Slope to drain, float finish, and edge.

B. Allow for a four-day cure of the concrete and install the cabinet, back to the fence and clear of the gates.

C. Mount the specified components in the cabinet in a neat manner, maximizing usable spare space. The Subcontractor may suggest alternate layouts for approval by the Engineer. The Subcontractor may pre-install, prior to cabinet installation, as much of the equipment as feasible. Special assembly permits may be required.

D. Specified terminal blocks shall be used for all interconnection work.

E. The control circuit may be modified as necessary to suit the control system of the operator installed. Advise the Engineer prior to modification, maintain accurate records, and include on record drawings.

3.5 DETECTOR LOOP INSTALLATION

A. Each detector loop shall be fed through a separate 3/4-inch GRSC conduit from the curb or edge of pavement to the control cabinet or gate operator.

B. Loops shall be made up with PVC Schedule 80 conduit with a tee condulet fitting with side access to connect PVC loop to GRSC conduit.

C. Saw cut loops into pavement with saw slots as described below:
   1. One single kerf made with a single pass of the saw.
   2. Approximately 1 1/4-inch wide by 1 1/4-inch deep.
   3. Slot walls and floors shall be free of projections which could damage conduit either during installation or in use.

D. The slot shall be clean and dry. Clean with pressure wash and air jet immediately before placement of conduit and sealant.

E.

F. Install wire in PVC loop as detailed:
   1. Install stranded copper wire, No. 14 AWG, type THWN insulation, continuous unspliced lengths from the terminals in the control panel.
   2. In loop, wires shall be five in parallel, without twist in PVC conduit.
   3. Leads from loop to detector shall be twisted at approximately four turns per foot to the detector terminal strip.

G. The loops shall be inspected and approved prior to installation of the epoxy. Once loop is placed and approved, slot must be filled before it can collect debris or get wet.

H. Following the instructions of the epoxy manufacturer, pour the epoxy in the slot, filling flush with pavement surface (cleanliness, dryness, and temperature are important).

I. Barricade to keep traffic off poured slots until epoxy is properly cured.

3.6 CONDUCTOR INSTALLATION

A. All conductors to be placed in a particular length of raceway shall be placed in the same pull.

B. Allow sufficient conductor free length for required makeups at each access point. Conductors pulled through a box without break shall have free loop sufficient for dressing in box.

C. Each conductor shall be identified at each access point and separated from the terminal strips with self-curing adhesive plastic wrap-around type labels with assigned identification. Use Brady, T&B, or equal, markers. Legends are indicated on the drawings.

3.7 CIRCUIT MAKEUP

A. Circuit wires shall connect to terminal blocks, or directly to device terminals where terminal blocks are not provided.

B. Ground wires shall be attached to the enclosures with approved lugs.

C. Splices in “hot” and “neutral” circuits shall be electrically and mechanically sound, and shall be insulated so no “hot” or “neutral” exposure is possible without cutting insulation.

D. Wiring shall be dressed into box so insulation is not subject to mechanical pressure, and does not conflict with devices or other wiring.

E. All wiring shall be neatly bundled and tied, and shall be adequately supported to prevent shifting.

3.8 KEYLESS ENTRY AND CARD READER STATIONS

A. Refer to Division 28 Specifications

3.9 PLC PROGRAMMING

A. Programming of the PLC will be done by Port Maintenance. Submit notification to the Port 48 hours in advance to schedule for programming.

3.10 TESTING

A. Test the gate operator to confirm all operation and control functions.

END OF SECTION 32 31 14

LOOP TEST DATA SHEET

INSTALLATION DETAIL		TEST DATA POST-MANUFACTURE				TEST DATA PRE-INSTALLATION				TEST DATA POST-INSTALLATION			
Location/Intersection	Loop #	Inductance	Resistance	Megger	Date	Inductance	Resistance	Megger	Date	Inductance	Resistance	Megger	Date

Manufacturer’s 10-year warranty begins as of the date of installation.

For valid warranty, copies of the above information, including dates, must be forwarded to Never-Fail Loop Systems.

SECTION 32 92 00 - CLEARING AND SEEDING

This Section includes project-specific modifications to FAA Item T-901 Seeding

DESCRIPTION

901-1.1 This item shall consist of soil preparation and seeding all areas disturbed by construction.

MATERIALS

901-2.1 Seed (as modified for Port of Portland Projects).
The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. The seed mix shall conform to the requirements of ORS 633. The seed mix shall be untreated tested seed of good quality and free of noxious weeds. Seed shall be dry, not moldy, and show no sign of having been wet or otherwise damaged.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and ORS 633 with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Subcontractor shall furnish the Port duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected. Seed mix shall be a three-way blend of endophyte enhanced dwarf turf type tall fescues meeting the following criteria:

Seed	Percent PLS	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Endophyte Enhanced
Seed Type 1	33	98	90	80 min
Seed Type 2	33	98	90	80 min
Seed Type 3	33	98	90	80 min
Inert Matter	1	--	--	--

PLS (pure live seed) is the amount of living, viable seed in a larger total amount of seed. The amount of seed to be applied is obtained by using the purity and germination percentages from the label on the actual bag of seed to be used on the project. To calculate the amount of seed to be applied:

a. Obtain the PLS factor by multiplying the seed label germination percentage times the seed label purity percentage;
b. Divide the specified PLS rate by the PLS factor;
c. Round off the result as approved.

For example, assume a PLS seeding rate of 350 lbs/acre is specified and the seed label shows a purity of 98 percent and germination of 90 percent. Multiply 0.98 by 0.90 to obtain a PLS factor of 0.88. The specified PLS rate of 350 lbs/acre, divided by the factor of 0.88, equals 397.73. Thus 400 lbs/acre of total

seed needs to be applied in order to meet a specified PLS seeding rate of 350 lbs/acre (approximately 1,600 seeds/sq ft).

Seeding shall be performed during the period between September 1 and October 15 inclusive, unless otherwise approved or directed by the Port. Seeding on stockpile areas shall be completed prior to September 1.

901-2.2 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers shall be a dry, free-flowing fertilizer suitable for application by a common fertilizer spreader. The minimum percentage of nutrients by weight shall be:

25 percent nitrogen, 5 percent potash, and 3 percent iron, slow release.

Fertilizer shall be applied at the rate recommended by the manufacturer.

901-2.3 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Engineer before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Subcontractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches as a result of grading operations and, if immediately prior to seeding, the top 3 inches of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches. Clods shall be broken and the top 3 inches of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity recommended by the manufacturer.

b. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

c. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot of width for sandy or light soils.

a-3.3 Wet application method.

a. General. The Subcontractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons per minute at a pressure of 100 lb / sq inches. The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet. One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet in length shall be provided to which the nozzles may be connected.

c. Mixtures. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds of these combined solids shall be added to and mixed with each 100 gallons of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Subcontractor shall identify to the Contractor all sources of water at least two (2) weeks prior to use. The Contractor may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Subcontractor shall not use any water from any source that is disapproved by the Contractor following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

901-3.4 Maintenance of seeded areas. The Subcontractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Subcontractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Subcontractor establish a good stand of grass of uniform color and density to the satisfaction of the Contractor. A grass stand shall be considered adequate when bare spots are one square foot or less, randomly dispersed, and do not exceed 3% of the area seeded.

REFERENCES

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

ASTM International (ASTM)

ASTM C602	Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF SECTION 32 90 00

SECTION 33 11 16 - WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes the work necessary for relocating an existing fire water main and installing a new fire water main, including all valves, fittings, blocking, tie rods, and other appurtenances, and relocating a water service lateral.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00, Cast-In-Place Concrete

B. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

1.3 REFERENCES

A. ANSI: American National Standards Institute.
   1. ANSI A21.4: Cement-Mortar Lining/Cast and Ductile-Iron Pipe and Fittings
   2. ANSI A21.6: Cast-Iron Pipe Centrifugally Cast in Metal Molds
   3. ANSI A21.11: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   4. ANSI A21.51: Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds

B. ASTM: American Society for Testing and Materials.
   1. ASTM B88: Standard Specification for Seamless Copper Water Tube

C. AWWA: American Waterworks Association.
   1. AWWA C104: Cement–Mortar Lining for Ductile Iron Pipe and Fittings for Water
   2. AWWA C106: American National Standard for Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water and Other Liquids
   3. AWWA C110: Ductile-Iron and Gray-Iron Fittings
   4. AWWA C111: Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
   5. AWWA C151: Ductile Iron Pipe, Centrifugally Cast, for Water
   6. AWWA C502: Dry-Barrel Fire Hydrants
   7. AWWA C504: Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm)
   8. AWWA C509: Resilient-Seated Gate Valves for Water Supply Service
   9. AWWA C550: Protective Interior Coatings for Valves and Hydrants
   10. AWWA C600: Installation of Ductile Iron Water Mains and Their Appurtenances

D. COP: City of Portland

E. Oregon State Department of Health

1.4 SUBMITTALS

A. Submit an acceptable certificate of water quality to the Engineer and Port.

B. Submit product data for the following:
1. Ductile iron pipe.
2. Copper tubing.
3. Fittings.
4. Valves.
5. Hydrants.
6. Valve boxes.
7. Indicator posts.
8. Thrust block concrete or joint restraints.
9. Other appurtenances as specified.

PART 2 - PRODUCTS

2.1 GASKETS FOR USED PIPE

A. Provide new gaskets for each section of pipe, fitting and valve for the 12-inch ductile iron pipe to be relocated, if the condition is determined by the Contractor and Port to be acceptable for reuse.

2.2 PIPE

A. Ductile Iron Pipe see Section 33 12 16 Underground Fire Protection Components

B. Copper Tubing: Type “K” or “L,” conforming to ASTM B88.

2.3 FITTINGS

2.4 See Section 33 12 16 Underground Fire Protection Components VALVES

A. Gate Valves: Meet the following requirements:
1. Sizes as indicated on the drawings.
2. Applicable provisions of AWWA C-509. UL and FM approved.
3. Cast iron bodies with valve ends required for connections as indicated.
4. Bronze-mounted, resilient-seated wedge type with non-rising stem; operation shall provide full withdrawal of discs from waterway for unrestricted passage.
5. Two “O” ring stem seals.
6. Gate valves shall be of the same manufacturer, or equal.
7. Meet working pressures of 200 psi.
8. Open counterclockwise.
9. Valves shall be provided with 2-inch square operating nuts.
10. Epoxy coated inside and out per AWWA C550.

11. Valves with indicator post shall be Mueller A2073-6, or equal.

B. OS&Y Valves: Outside screw and yoke gate valve shall be Mueller A2073-6, or equal.

2.5 VALVE BOXES

A. Valve boxes shall be No. 2 (8 1/2-inch I.D.). C.I. Valve Box and cover per City of Portland Standard Plan No. 5-603.

2.6 HYDRANTS

A. Subcontractor-furnished fire hydrants shall be in accordance with the following:
1. Corey type.
2. Meet AWWA C502 specifications. FM approved.
3. Have 6-inch flanged joint inlet.
4. Have one 4 1/2-inch pumper connection and two 2 1/2-inch hose connections with ANSI B26 standard threads.
5. Have "O" ring seals on operating stem.
6. Operating stem nut dimensions conforming to City of Portland Fire Bureau specifications.
7. Open counterclockwise.
8. Have break-off joint located approximately 2 inches above ground surface.
9. Have drain hole in base.

2.7 CORPORATION STOPS

A. Size indicated on the drawings.

B. Mueller, or equal.

2.8 UNION COUPLING

A. The copper-to-copper union couplings shall be as manufactured by Mueller, or equal.

2.9 INDICATOR POSTS

A. Indicator posts for on-site gate valves shall be:
1. Adjustable type.
2. UL and FM approved device.

PART 3 - EXECUTION

3.1 TRENCHING, BACKFILLING, AND COMPACTING

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems.

3.2 LAYING PIPE AND FITTINGS

A. General:
   1. Furnish all fittings, jointing compounds, bolts, rubber rings, and other material necessary for making joints.
   2. Inspect each length of pipe before laying.
   3. Replace defective pieces.
   4. Carefully clean pipe and fittings before laying.
   5. Use tools and equipment which will not damage pipe.

B. Installation:
   1. Install per Section 33 12 16 Underground Fire Protection Components

3.3 CONNECTIONS TO EXISTING PIPES

A. Make connections to existing pipes in a workmanlike manner. Make with closure pieces after the pipeline has been sterilized and tested. Refer to Section 33 12 16 Underground Fire Protection Components

3.4 UTILITY WARNING TAPE

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems .

3.5 TESTING PIPE

A. Testing procedures and leakage allowance shall be in accordance with AWWA C-600, unless noted otherwise in Section 33 12 16 Underground Fire Protection Components

B. Testing procedures and equipment shall be approved by the Contractor and Port.

C. The final backfilling of the trench shall be completed upon completion of a satisfactory test, and upon approval by the Contractor and Port.

3.6 STERILIZING WATER LINES

A. The Subcontractor shall familiarize itself with the Oregon Department of Health recommendations for water main sterilization and follow the directions thereof.

B. After completion of the pressure tests, flush the pipelines to remove silt or debris and sterilize in conformity with the recommendations of the Oregon State Department of Health. Using either liquid chlorine with an appropriate solution feeder or a solution of calcium or sodium hypochlorite, the pipelines shall be filled with water containing at least 25 parts per million of available chlorine. This solution shall remain in the lines for 24 hours, at which time the chlorine residue shall be measured and shall not be less than 10 parts per million.

END OF SECTION 33 11 16

SECTION 331216 – UNDERGROUND FIRE PROTECTION COMPONENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY:

A. Furnish all labor, material, and equipment for a fully-operating, fully-restrained underground firewater yard system in compliance with referenced codes and standards for the following components:
   1. Pipe.
   2. Coatings.
   3. Wrappings.
   4. Restrained joint systems.

1.03 REFERENCES:

A. Applicable Standards (Latest edition unless otherwise noted):
   1. 2022 Portland Specialty Structural code (PBC)
   2. 2022 Portland Fire Code (PFC)
   3. Local Codes including local policies, interpretation, and standards.
   4. ASME International (ASME):
      a. B16.5 – Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24.
      b. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings, Class 150 and 300.
      c. B16.47 – Large Diameter Steel Flanges.
      d. B31.3 – Process Piping.
      e. B31.9 – Building Services Piping.
   5. American Society for Testing and Materials (ASTM):
      a. A193 – Standard Specification for Alloy-Steel and Stainless Steel bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
      b. A194 – Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
      c. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
      d. A563 – Standard Specification for Carbon and Alloy Steel Nuts.
      e. D638 – Test Method for Tensile Properties of Plastics.
      f. D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulated Materials.
      g. D1238 – Measuring Flow Rates of Thermoplastics by Extrusion Plastometer.
      h. D1241 – Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
      i. D1505 – Test Method for Density of Plastics by the Density-Gradient Technique.
      j. D2774 – Standard Practice for Underground Installation of Thermoplastic Pressure Piping
      k. D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
      l. D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

m. D3261 – Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene Plastic Pipe and Tubing.
n. D3350 – Polyethylene Plastics Pipe and Fittings Materials.
o. D4976 – Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
p. F436 – Standard Specification for Hardened Steel Washers.
q. F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter (Outside diameters exceeding DIPS 3, IPS 4, and Metric 90 mm).
r. F1473 – Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
s. F1476 – Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
t. F2164 – Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
u. F2206 – Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).
v. F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
w. F2634 – Standard Test Method for Laboratory Testing of Polyethylene (PE) Butt Fusion Joints Using Tensile-Impact Method
x. F2880 – Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4” in. to 65 in.
y. F3183 – Standard Practice for Guided Bend Evaluation of Polyethylene Pipe Butt Fusion Joint

6. American Water Works Association (AWWA):
a. C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
b. C105 – Polyethylene Encasement for Ductile Iron Pipe.
c. C207 – Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In.
d. C110 – Ductile-iron and Gray-Iron Fittings.
e. C111 – Rubber-Gasketed Joints for Ductile-Iron Pressure Pipe and Fittings.
f. C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
g. C150 – Thickness Design of Ductile-Iron Pipe.
h. C151 – Ductile-Iron Pipe, Centrifugally Cast.
i. C153 – Ductile-Iron Compact Fittings.
j. C209 – Cold-Applied Tape Coatings for Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
k. C210 – Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Pipelines.
l. C213 – Fusion-Bonded Epoxy Coating for the Interior and Exterior Surfaces of Steel Piping.
m. C217 – Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Pipelines.
n. C219 – Bolted Sleeve-Type Couplings for Plain-End Pipe.
o. C222 – Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
p. C906 – Polyethylene Pressure Pipe and Fittings, 4 In. through 65 In. for Waterworks.
q. M41 – Ductile-Iron Pipe and Fittings.
r. M55 – PE Pipe – Design and Installation.

7. Association for Materials Protection and Performance (AMPP) (formerly the Society for Protective Coatings (SSPC)):
   a. SSPC-SP 7 (NACE 4) – Brush-Off Blast Cleaning.
   b. SSPC-SP 10 (NACE 5) – Near-White Blast Cleaning.
   c. SSPC-SP 16 – Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-ferrous metals.
8. FM Global:
   a. Fire Protection Approval Guide.
   b. FM Approval Standard.
      1. FM 1613 – Approval Standard for Polyethylene (PE) Pipe and Fittings for Underground Fire Protection Service.
9. National Association for Pipe Coating Applications, Specifications and Plant Coating Guide Bulletins (NAPCA):
   a. 12-78-94 – External Application Procedures for Plant Applied Fusion Bond Epoxy (FBE) Coatings to Steel Pipe.
   b. 6-69-94-3 – Suggested Procedures for Coating Field Joints, Fittings, Connections, and Pre-Fabricated Sections Using Tape Coatings.
10. National Fire Protection Association (NFPA):
    a. 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
    b. 25 – Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
11. Plastics Piping Institute (PPI):
    a. Handbook of Polyethylene Pipe 2nd Edition (2008).
    b. TN-38 –Polyethylene Flanged Joints (2021).
    c. TN-46 – Guidance for Field Hydrostatic Testing of High Density Polyethylene Pressure Pipelines: Owner's Considerations, Planning, Procedures, and Checklists 2021).
    d. TR-4 – PPI Listing of HDB, HDS, SDB, PDB, and MRS Ratings for Thermoplastic Pipe Materials or Pipe (2018).
12. Society of Automotive Engineers (SAE):
    a. J429 – Mechanical and Material Requirements for Externally Threaded Fasteners.
13. Underwriters Laboratories Inc. (UL):
    a. Fire Protection Equipment Directory.
    b. 213 – Rubber Gasketed Fittings for Fire Protection Service.

1.04 SYSTEM PERFORMANCE REQUIREMENTS:

A. Design and install fire suppression pipe and components in accordance with applicable codes and standards, manufacturers' recommendation and Contract Documents.

1.05 SUBMITTALS:

A. Product Data:
   1. Piping material, including fittings, transitions, gaskets, and adapters.
   2. Warning tape.
   3. Coating products.
   4. Appurtenances.
   5. Written testing procedure for underground piping:
      a. If piping is ferrous or ductile, the procedure shall be in accordance NFPA 24.
      b. If HDPE pipe is used, the procedure shall be in accordance Handbook for PE pipe, AWWA M55, ASTM F2164, and TN-46 considering actual ambient test conditions.

c. If multiple pipe types are used, the procedure shall incorporate appropriate testing requirements for each section such that the complete system is tested.

B. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements as described in NFPA 24 and altered in accordance with Handbook for PE pipe, AWWA M55, ASTM F2164, and TN-46 where High-Density Polyethylene (HDPE) pipe is used. Include "Contractor's Material and Test Certificate for Underground Piping" along with appropriate modifications as necessary for proper HDPE usage including appropriate temperature derating, test pressures, testing durations, pipe relaxation requirements, and bolt retorquing.

C. Provide documentation demonstrating factory training has taken place for personnel providing the installation of the HDPE piping with the shop submittal documents.

D. Provide HDPE Butt-Fusion training certificates.

E. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE:

A. Fire-suppression-system piping, installation, and testing shall comply with the following:
1. NFPA 24.
2. AWWA M23.
3. AWWA M55.
4. ASTM F2164.
5. ASTM F2620.
6. Handbook for PE Pipe.
7. TN-46.

B. Subcontractor shall be experienced in the installation of HDPE pipe, fittings, and specialties for a minimum period of 5 years.

C. Only factory trained personnel shall install HDPE piping.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Do not damage the pipe by impact, bending, compression, or abrasion during handling and storage.

B. Store pipe on a flat surface which provides even support for the barrel with ends overhanging.

C. Do not stack pipe higher than 5-feet.

D. Use only nylon-protected slings or hands to handle pipe. Do not use hooks or bare cables.

1.08 COORDINATION:

A. Coordinate design and installation of underground firewater piping with other belowground installation including other piping systems as well as footings. Care was taken in locating the piping in locations which will minimize obstructions, the Subcontractor shall take responsibility for precise location of underground firewater piping. Install underground firewater piping in accordance with the Contract Documents as far as practical.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Subject to compliance with requirements, provide products which are UL Listed in the Fire Protection Equipment Directory and/or FM Approved in the FM Fire Protection Approval Guide for their intended use unless noted otherwise.

2.02 DUCTILE IRON PIPE AND FITTINGS:

A. Exposure: Buried or aboveground.

B. Flanged, threaded, or plain-end, ductile iron pipe:

1. Ductile Iron pipe shall have minimum pressure classification as follows per AWWA C150, AWWA C151, and AWWA M41:
   a. Piping shall be minimum Class 350 for sizes 4 in. through 12 in.
2. Provide threaded pipe ends in accordance with AWWA C115.
3. Provide Class 150 ASME B16.42 flanged ends in accordance with AWWA C110, AWWA C111, and AWWA C115.
4. Bolted sleeve-type couplings for plain end pipe shall be in accordance with AWWA C219 with appropriate internal diameters corresponding to the OD's of the piping to be coupled.
   a. Joint separation prevention of the coupling shall be provided by means indicated in NFPA 24 – Underground Restraint regardless of whether the coupling is installed aboveground or below ground.

2.03 NUTS, BOLTS, AND WASHERS:

A. Exposure: Buried or aboveground.

B. Flanged connections, restraint systems.

1. Sizing shall comply with flange classification requirements.
2. Fully-tightened nuts shall reveal a minimum of two fully-exposed threads.
3. Aboveground bolts shall be a minimum SAE J429 Grade 2 or Grade 5 and shall be PTFE, Cerakote, Xylan 1014, or Teflon coated.
4. Underground bolts shall be a minimum ASTM A193 B7 and shall be PTFE, Cerakote, Xylan 1014, or Teflon coated.
5. Aboveground nuts shall be a minimum ASTM A307 Grade B with heavy hex head whose contact surface approximates the diameter of washers.
6. Underground nuts shall be a minimum ASTM A194 stainless steel with heavy hex head whose contact surface approximates the diameter of washers as a minimum and shall be PTFE, Cerakote, Xylan 1014, or Teflon coated.
7. Washers are not required between nuts or bolt heads and fully machined surfaces or surfaces cut from plate steel.
   a. Where used, washers shall be SAE, through-hardened, and heat-treated. They shall not be case-hardened per TN-38.
   b. Washers may be conical (Bellville) if the flange cannot be accessed again for retorque to aid in torque retention.
   c. Washer material composition and finish shall comply with ASTM F436 and/or shall match that of the bolts and nuts used.
   d. Washers are required where indicated to be part of a listed assembly.

2.04 CORROSION-PROTECTION FOR PIPING:

A. All exposed metal threads and metal pipe dings, nicks, cut surfaces, and scratches shall be treated with a coating of acid-etching primer and cured prior to additional coatings being applied.

B. Corrosion-protective encasement for underground/aboveground metal piping, fittings, and components shall be provided after installation per NFPA 24:

1. After following the procedure spelled out in SSPC-SP 7, SP 10, or SP 16, all underground metal pipe, flanges, bolts, and couplings shall be externally protected against corrosion by one of the following coatings:
   a. Two-part shop-applied fusion-bond epoxy in accordance with NAPCA Bulletin 12-78-94 per AWWA C210 or AWWA C213:

1. SPC-SP2888.
2. 3M Scotchkote 323.
3. Carboline Polyclad 975.

b. Wax Tape and priming system in accordance with NAPCA Bulletin 6-69-94-3 per AWWA C217 or Tape coating systems per AWWA C209 or AWWA C217:
1. Far West Corrosion.
2. Trenton.
3. Desco.

c. All underground ductile iron pipe shall be polyethylene coated in accordance with AWWA C105.

d. All underground pipes and fittings shall be protectively coated in accordance with AWWA C222 or AWWA C550.

2. Corrosion-protective lining for metal piping, fittings, and components:
a. All underground (aboveground) ductile iron pipe shall be cement-mortar lined in accordance with AWWA C104.

2.05 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS:

A. Exposure: Buried.

B. Furnish pipe of materials, rating, joint type, and size as indicated or specified. Furnish maximum pipe lengths produced by the manufacturer.

C. Pipe Design Conditions:
1. Designed to withstand all stresses resulting from external loads and internal pressures listed in Table 2, plus applicable allowances for surge.

Table 2 - HDPE Pipe Design Conditions

Application	Pipe Type	Nominal Pipe Size	Pressure Class	Live Load
Firewater	FM Approved Rating	8 inch	IPS Class 250	H2O

D. Furnish special fittings or adapters as required to join two pipes, fittings, or accessories of dissimilar material.

E. Material:
1. Requirements: HDPE pipe and fittings shall comply with ASTM D3261, ASTM 2206, and/or ASTM 2620 and be made from a high density, extra high molecular weight material with a broad range molecular weight distribution designated as an FM approved PE 4710 per FM 1613 with ASTM D3350 cell classification number of 445474C or higher as manufactured by:
a. Driscopipe.
b. Georg Fischer Central Plastics.
c. Isco Industries.
d. Plasson.
e. Plexco.
f. WL Plastics.
g. Wolseley.
h. Approved equal.
2. Cell classification description in Table 3:

Table 3 – Cell Classification Description

Cell Classification	Property	Cell Classification Limits
4	Density per ASTM D1505	0.955 - 0.957 gm/cm^3

4	Melt index per ASTM D1238	0.10 - 0.15 gm/10 min
5	Flexural modulus per ASTM D790	110,000 - 140,000 psi
4	Tensile strength per ASTM D638	3200 min psi
7	Pent per ASTM F1473	>100 hours
4	Hydrostatic Design Basis @ 73°F per ASTM D2837	1600 psi
C	Color and Ultraviolet Stabilizer	Black 2 to 2.5% Carbon Black

F. Manufacturing Requirements:
   1. All pipe shall be made from virgin material, or from rework compound obtained from the manufacturer's own production of the same formulation.
      a. Typical field maximum lengths are 50 ft where straight piping is to be run.
      b. Typical fabrication maximum lengths are 40 ft.
   2. Manufacture piping in accordance with ASTM D3035 and ASTM F714.
   3. Maximum Hydrostatic Design Stress at 73°F shall be 1000 psi per TR-4 and ASTM D3350.

G. HDPE pipe or connection to other HDPE pipe or fittings shall be butt-fusion-welded in accordance with ASTM D3261 and ASTM F2620, FM Approved back-to-back flange adapters in accordance with ASTM F2880, or fittings with gripping teeth to bite into plain-end HDPE pipe – all of which provide restraint from separation per NFPA 24. Fitting manufacturers include:
   1. Driscopipe.
   2. Georg Fisher Central Plastics.
   3. Isco Industries.
   4. Plasson.
   5. Plexco.
   6. Romac.
   7. Victaulic.
   8. WL Plastics.
   9. Wolseley.
   10. Approved Equal.
   11. Flowable fill may be included at changes in direction if necessary but is not required per NFPA 24.

H. HDPE electrofusion shall not be used to join HDPE pipe and fittings.

I. HDPE fittings:
   1. Fittings shall be IPS FM Class 200 matching the FM classification of the piping to which is it connected unless specified otherwise. (EDR – equivalent diametric ratio may be used. Reference by pressure classification is preferred by fitting manufacturers. Class 335 fittings and piping have the same DR)
   2. Elbows, straight and reducing tees, reducers, and stub ends shall be factory-fabricated with plain ends for butt fusion per ASTM D3261 and ASTM F2620.
   3. Molded fittings shall be shop-manufactured and fabricated to ASTM F2206, AWWA C605 and AWWA C906.
   4. Fabricated fittings shall be shop-manufactured and fabricated to ASTM F2206, AWWA C605 and AWWA C906.

5. Adapters shall conform to ASTM F2880 and use ductile iron backing rings which are coated after installation and have been placed over the HDPE pipe to be butt-fused prior to the HDPE flange adapter and the HDPE pipe being fused.
    a. Per ASTM F2880, flanged adapter backing rings are drilled for Class 150 bolt hole patterns per ASME B16.5, ASME B16.47, and AWWA C207 regardless of fitting classification.
6. Persons making heat fusion joints shall have received training in the manufacturer's recommended procedure and shall have proof of certification upon request.
7. Where approved for use, grooved couplings may be used if in compliance with ASTM F1476 and AWWA C606.

2.06 GASKETS:

A. Gaskets for Steel and Ductile Iron flanged connections shall be of appropriate type for the specific connection they are intended in accordance with ASTM F1476, AWWA C110, AWWA C111, AWWA C153, AWWA C606, or UL 213.
    1. Other gasket types may be allowed as appropriate for the specific joint-type and shall be individually evaluated.
    2. Gaskets shall be provided as recommended by the coupling, fitting, or piping manufacturer as appropriate for:
        a. the fluid inside the pipe,
        b. maximum internal pressure,
        c. mating components, and
        d. exterior ambient conditions.
B. If gaskets are used for HDPE interfaces, they shall be reinforced-, full-face-type, monolithic, having a 60 to 75 Shore-A hardness similar to the following per TN-38):
    1. Garlock:
        a. Gylon Style 3545.
        b. Multi-Swell Style 3760/U.
    2. Klinger 3000 green.
    3. Approved Equal.

PART 3 - EXECUTION

3.01 EARTHWORK:

A. Refer to Contract Documents for excavating, trenching, and backfilling requirements.
B. Bollards shall be provided as indicated to provide protection from mechanical damage for aboveground firewater appurtenances.

3.02 GENERAL PIPING APPLICATIONS:

A. Align flange bolt pattern on each end of spool.
B. Provide flanged fittings, unions, nipples, transition, and specialty fittings with finish and pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
C. Subcontractor is responsible for providing the following items including but not limited to the following to provide a complete-, code compliant-, and functional firewater system: piping; fittings; transitions; written and preapproved testing procedure in accordance with NFPA 24 as further modified by AWWA M23, AWWA M41, AWWA M55, ASTM D2774, ASTM F2164, Handbook for PE Pipe, and/or TN-46 as necessary and appropriate for the pipe; testing equipment, detectable buried warning identification tape, concrete blocks, and drain-field components as indicated in Contract Documents and required to complete the system.
D. Removed piping and equipment shall be properly disposed of off-site by Subcontractor.

3.03 MECHANICAL PROTECTION:

A. Bollards shall be provided as necessary by the Subcontractor protecting aboveground firewater appurtenance extensions as indicated on the Contract Documents.

B. Piping depth of cover shall comply with NFPA 24 minimums for foam solution live-loads or shall be sleeved or encased as required per consultation with the civil engineer for anticipated loads expected on the pipe.

3.04 PIPING INSTALLATION:

A. Location and Arrangement: Drawings, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated where practical.
   1. Deviations from approved working plans for piping require written approval from Contractor.
   2. HDPE fusion procedure shall only occur under dry pipe conditions where both the interior and exterior surfaces are free of moisture.

B. Install underground (aboveground) pipe in accordance with referenced codes, standards, and manufacturer's recommendations.
   1. All piping within the scope of work shall be restrained from separation at any joint in accordance with NFPA 24. This includes possible separation of joints outside the scope of work due to unknown restraint methods therein where separation may be possible because of scope of work piping system modifications. All scope of work piping shall include 'bookended restraint per NFPA 24' appropriately in each respective system section's linear direction inclusive of configurations up to 90° changes in direction.
   2. After installation; rods, nuts, bolts, washers, clamps, flanges, and other restraining devices used to anchor piping shall be cleaned and thoroughly coated with a bituminous or other acceptable corrosion-retarding material per NFPA 24 or as required by the manufacturer.
   3. Backfilling of underground plastic piping shall have maximum embedment particle sizes in contact with pipe in accordance with ASTM D1241, ASTM D2774, and the Handbook for Polyethylene Pipe as follows:
      a. ¾" for 6" and 8" nominal diameter.
   4. Spacing of underground piping:
      a. Multiple pipes running parallel to each other shall be spaced at least 1'-0" near edge to near edge to allow appropriate backfilling and compaction.
      b. Where new pipe crosses new or existing piping, minimum spacing shall be at least 1'-0" below from near edge to near edge.

C. Gaskets:
   1. Gaskets shall be appropriate for mating the two connections making up each respective joint in accordance with ASTM F1476 and AWWA C606.
   2. Gaskets shall be provided in all metal-to-metal flange connections.
   3. Careful evaluation is necessary where gaskets may be used on HDPE piping.
      a. Gaskets used with HDPE connections shall be full-face and designed to seal properly with an assembly stress of 1200-1800 psi and soft enough to conform to the HDPE flange adapter sealing surface without causing damage to the surfaces per TN-38.
      b. Gaskets shall not be provided between any flanged joints where both sides are HDPE where operational pressures are below 250 psig.
      c. Elastomeric gaskets are not permitted.
      d. If internal HDPE pipe pressures are less than 80 psi, gaskets are not required.

D. Flange bolt torquing process:
   1. A precise load controlling tool shall be used to torque all bolts.
   2. Metal to metal joints:

a. Torquing for metal-to-metal flange interfaces shall be either legacy- or alternative-cross-pattern tightened in accordance with ASME PCC-1 for which examples are given in Tables 1, 2, 4, 4.1, and O-9.

3. HDPE-to-metal or HDPE-to-HDPE shall be documented and in accordance with TN-38 as follows:
   a. All HDPE flange adapters shall include one-piece backing rings.
   b. Torquing requirements for joints involving HDPE shall be calculated by the subcontractor. As a minimum, they shall comply with the requirements following TN-38 Section 6 and tables as appropriate with proper modifications as determined necessary for inclusion in the flange torque record documentation with the appropriate applied torque per bolt. Each torque value shall be as derived per the equation found in TN-38 Section 6 which is based on SAE J429 Grade 2 or Grade 5 bolts, ASTM A563 Grade A nut, appropriate pipe fittings and surfaces at the interface, and the referenced gasket components used as further modified by the gasket manufacturer.
      1. Joints where both interface surfaces are HDPE will be higher than those where one interface is HDPE.
      2. Joint loading shall be based on actual congruent interface surface area in that joint based on pipe and fitting IDs and adapter hub OD as appropriate.
      3. The target interfacial pressure from which the bolt torque shall be derived shall be as follows per TN-38:
         (a) Most applications – 1,800 psi.
         (b) Low pressure applications (<60 psi) using an elastomeric gasket – 1,200 psi.
      4. TN-38 (2019 and older) Table 2 provides example bolt torques where both sides of the joint are HDPE.
      5. TN-38 (2019 and older) Table 3 provides example bolt torques where one side of the joint is HDPE.
   c. Connections anticipated to be disassembled shall include a gasket.
   d. Tightening of bolts shall be in accordance with TN-38 (2021) Section 7.4
   e. During bolt loading, bolts shall be held and nuts shall be rotated.
   f. Bolt torquing progression:
      1. 30-30 rule for flanges less than 18” nominal pipe size.
   g. All flanged connections having HDPE shall be retorqued as required per the Handbook of Polyethylene Pipe and TN-38 prior to testing:
      1. For pipe diameters 12” and smaller – after 4 hours.
   h. Disassembly of any torqued flanged connection shall not de-load individual bolts but shall be the torquing process per TN-38 in reverse and shall occur only after piping has been depressurized.
   i. Nuts used in flanged connections shall not be reused.
4. Bolt torquing shall keep the flanges square with concentric loading with a single precise load controlling tool as defined in ASME B31.3 Section 300.2 for intermediate- or normal fluid-service per the definition of fluid service(a) Category D Fluid Service regardless of system design pressure.

E. When connecting PE pipe to the bell end of a ductile iron, an HDPE pipe stiffener component shall be added to the ID of the pipe to insure adequate compressive resistance for the HDPE pipe end between the seal in the bell and the pipe.
F. Use approved fittings to make changes in direction and reductions in pipe sizes.
G. Install flanges or flange adapters on apparatus and equipment.
H. Install underground piping as shown on the Contract Documents. Provide markers at appurtenance locations so that they can be located at a future date.

I. Provide detectable identification tape directly above all underground plastic piping per the trench detail notes on Contract Documents and as indicated herein.

J. Provide daily field destructive quality-control testing of HDPE butt-fused joints in accordance with ASTM F2620 for pipe walls less than 1" thick or ASTM F3183 for pipe walls 1" and thicker.

3.05 LABELING AND IDENTIFICATION:

A. Provide labels for all appurtenances in accordance with the Contract Documents.

3.06 FIELD QUALITY CONTROL:

A. Where HDPE is butt-fusion-jointed, perform documented periodic weekly fusion quality destructive testing of all pipe size- and DR rating-combinations with sufficiently conditioned samples in accordance with one of the following methods:
   1. Pipe joint bonding shall be documented using a data logger on the fusion machine, or by recording pertinent butt fusion data including:
      a. Air temperature and atmospheric conditions at time of bonding.
      b. Joint identification (line number/identifier, joint number, drawing/is number, location, etc.).
      c. Fuser/Bonder name or identifying number.
      d. Fusion machine serial or equipment number.
      e. Fusion procedure name/number.
      f. Pipe size and diameter.
      g. Joint Configuration with appropriate bolt torque.
      h. Heating tool temperature.
      i. Drag Pressure.
      j. Gauge pressure during the initial heating cycle.
      k. Gauge Pressure and elapsed time during the heat soak cycle.
      l. Gauge pressure during the fusing/cling cycle.
      m. Elapsed time during the fusing/cling cycle.
   2. Laboratory tensile testing:
      a. Samples subjected to tensile testing in accordance with ASTM D638.
      b. Samples subjected to the tensile-impact test in accordance with ASTM F2634.
   3. Field or laboratory bent strap testing:
      a. Sample wall thicknesses of less than 1" shall be bend-tested in accordance with ASTM F2620.
      b. Sample wall thicknesses of 1" or greater shall be side-bend-tested in accordance with ASTM F3183.
   4. Test coupons shall not be cut prior to conditioning to between 65°F and 75°F as verified by a calibrated surface pyrometer via one of the following methods:
      a. Four hours in air per ASTM F3183,
      b. One hour in water per ASTM F3183, or
      c. As recommended by the pipe manufacturer.
   5. Each single test butt-fuse shall include four samples each which are cut from different quadrants of the fused joint at 90° from each other.

B. All coupons from any live-tap- or other cut-in fittings shall be verified retrieved prior to proceeding to flushing and leak testing.

C. After installation and agreement on the written piping system test procedure, perform the flushing of all system piping and appurtenances until water flow is verified clear of debris in accordance with NFPA 24. Do not perform hydrostatic and leak testing until flushing is complete.

1. Minimum flow rate for each section of pipe shall be sufficient to achieve a velocity of 10 ft/s or maximum flow rate available to the system whichever is lower.
2. To prevent water hammer, flushing of HDPE piping shall occur after the system has been properly filled in accordance with the preliminary portion of the Hydrostatic Pressure Rebound Method Leak Test as indicated in TN-46 and ASTM F2164.

D. Prior to leak testing, a prepared written pre-commissioning hydrostatic test procedure shall be provided for Ductile Iron in accordance with NFPA 24, for HDPE in accordance with ASTM F2164 and TN-46. Examples of procedures and checklists are found in TN-46 as well as the following herein. Appropriate data recording equipment shall be used, and signoff of each test section shall be documented.
   1. Provide the written test procedure to the Contractor for review prior to testing.
   2. The procedure shall include consideration of the following:
      a. Test section size and extents.
      b. Operating/maximum ambient earth temperature conditions.
      c. Testing maximum ambient temperature conditions if different than operating.
         1. Testing outside the trench is allowed if the piping is being slip-lined or directionally-drilled.
         2. The test section of HDPE piping should at minimum be protected from direct sunlight. This may be accomplished by backfilling sections between joints and/or shading the exposed test sections.
            (a) Summertime testing is recommended to be performed in the early morning to minimize derated design temperature-derived pressures from actual test temperature derated test pressures.
      d. Maximum system operating pressure.
      e. Accumulatively derate pressure classification of piping as necessary:
         1. Effective temperature-derated pressure classification of piping during operation.
            (a) Must exceed maximum system operating pressure.
            (b) Without manufacturer's specific temperature derating values, use Table 4 below for HDPE based on worst-case of multiple HDPE manufacturers (linear interpolation is allowed):

Table 4 – HDPE Temperature Derating Factors

Temperature (°F)	Derating factor (HDPE pressure class at 73°F multiplied by this factor to achieve effective pressure class)
40	1.22
50	1.15
60	1.08
73	1.00
80	0.94
90	0.86
100	0.78
110	0.75
120	0.63
130	0.6
140	0.5

Note: The derating factor does not change based on pipe class.

Table 6 – PE4710 HDPE Allowable Surge Pressures/Velocities Without Pressure Class Derating

Diametric Ratio (DR)	Standard Static Pressure Rating (PR) or Standard Pressure Class (PC) for Water @ 73°F	Resultant Allowable Sudden Change in Velocity (ft/s)
17	125	11.2
13.5	160	12.4
11	200	14.0
9	250	15.4
7.3	320	17.4

f. Rated pressure of other system components.
   1. Verify whether these components can be isolated during testing.
g. Test medium (water) shall be between 40°F and 90°F.
h. Test pressure at 1.5 times the effective derated pressure classification or maximum rated pressure of other system components but never more than the maximum design operating pressure of the system at the lowest point along the pipeline per ASTM F2164, AWWA M55, and TN-46.
i. Time of day for test:
   1. Start.
   2. Anticipated completion.
j. Duration of all three test phases of the HDPE Hydrostatic Pressure Rebound Method Leak Test as outlined in ASTM F2164 shall not exceed 8 hours:
   1. Preliminary – Filling with water and removal of air.
   2. Secondary – Initial expansion phase – water added to increase/maintain test pressure, not to exceed 4 hours.
   3. Final – Test phase – reduce test pressure by 10 psi and monitor pressure, typically 1 hour, not to exceed 4 hours.
k. Duration or relax time for the test section since the previous test shall be at least 8 hours.
l. Air temperature during time of test.
m. Location of test section – backfilled or exposed.
n. Direct sunlight on piping.
o. Time since last fusion on test section.
p. Test preparations by facilities.
q. Contractor notification.
r. Any cast concrete has cured for at least 7 days.
s. Do not test in wet weather.
t. Permits obtained.
u. Filling velocity control.
v. Controlled and complete air removal from the test section upon filling.
w. Allowance of air reintroduction if test section is to be emptied of water in a controlled manner.
x. Volumetric fill and drain-down procedure.
y. Rate of pressurization.
z. Flanges torqued and retorqued with correct torque per bolt documentation per TN-38.

1. Some test flanges exposed for visual inspection and possible retorquing after removal of test pressure.

aa. Appropriate and calibrated test equipment.
bb. Safety of witnesses during testing.
cc. Communication of test participants.

3. In-service leak testing is limited to visual verification of zero leakage at 100% of the maximum system working pressure on all connections involved in the repair per NFPA 24 Section 10.10.2.3.1 under the following conditions.
   a. Existing system modifications where the majority of the test section has previously been leak tested per NFPA 24, ASTM F2164, TN-46, or ASTM D2774
   b. Repairs such as cut-in tees, repair sleeves, or hot-taps which cannot be easily isolated from the rest of the existing system.
   c. Additional requirements for sections containing HDPE pipe or fittings include the all the following
      1. Minimum verification period duration shall be 1 hour.
      2. The test section shall not be exposed to direct sunlight.

E. Perform the hydrostatic test on all ferrous metal system portions of 200 psig or 50 psi more than system working pressure, whichever is greater, with not more than 5 psig loss/gain in 2 hours; in accordance with NFPA 24.
F. Perform the leak test in accordance with the written procedure.
G. Prepare test reports as appropriate:
   1. HDPE Hydrostatic Pressure Rebound Method Leak Test as outlined in ASTM F2164: In accordance with underground pipe testing requirements in AWWA M55, Handbook for PE Pipe, and TN-46.
   2. Piping sections downstream of isolation valves beyond which are not under constant static pressure, such as isolating manifolds; shall not be included in the leakage requirements of the pressure testing of the system piping. Those sections shall be visually inspected for leakage under pressure per the in-service testing parameters herein.
      a. Testing for these sections shall be limited to system operating pressure and flushing under which, there shall be no leakage.
   3. Testing shall meet the requirements of ASME B31.3, ASME B31.9, AWWA M23, AWWA M55, and NFPA 24 as applicable.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Furnish the Contractor with a completed and signed Contractor's Material and Test Certificate for Underground Piping prior to bury of the underground systems according to NFPA 24.
      a. Include HDPE Hydrostatic Pressure Rebound Method Leak Test results for all system test sections as appropriate.
   6. Coordinate with fire-pump tests. Operate as required for adequate flow for flushing of all piping sections as required per NFPA 24.
H. Report all test results promptly and in writing to the Contractor.

3.07 CLEANING AND PROTECTION:
A. Clean dirt and debris from nozzles.
B. Protect nozzles from damage until Substantial Completion.

3.08 DEMONSTRATION:
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain piping systems.

END OF SECTION 331216

SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the installation of sanitary sewer piping and related structures.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

1.3 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials
   1. AASHTO M252: Standard Specification for Corrugated Polyethylene Drainage Pipe
   2. AASHTO M278: Standard Specification for Class PS46 Poly(Vinyl Chloride) (PVC) Pipe
   3. AASHTO M294: Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
   4. AASHTO MP7: Standard Specification for Corrugated Polyethylene Pipe, 1350 and 1500 mm Diameter

B. ASTM: American Society for Testing and Materials
   1. ASTM A74: Standard Specification for Cast Iron Soil Pipe and Fittings
   2. ASTM A746: Standard Specification for Ductile Iron Gravity Sewer Pipe
   3. ASTM C33: Standard Specification for Concrete Aggregates
   4. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
   5. ASTM C150: Standard Specification for Portland Cement
   6. ASTM C595: Standard Specification for Blended Hydraulic Cements
   7. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
   8. ASTM D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
   9. ASTM D2661: Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
   10. ASTM D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
   11. ASTM D3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
   12. ASTM D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
   13. ASTM D3965: Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
   14. ASTM D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity

15. ASTM D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
16. ASTM D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile
17. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
18. ASTM F758: Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

C. AWWA: American Water Works Association
   1. AWWA C600: Installation of Ductile Iron Water Mains and Their Appurtenances

D. CISPI: Cast Iron Soil Pipe Institute

E. COP: City of Portland

1.4 SUBMITTALS/CERTIFICATIONS

A. Submit certifications showing that materials meet the requirements shown on the drawings and as specified below.

PART 2 - PRODUCTS

2.1 GROUT

A. Shall be non-shrink, non-ferrous, non-epoxy with a minimum design strength of 5,000 psi in 28 calendar days.

B. Use according to manufacturer's recommendations.

2.2 ANTI-SEIZE LUBRICANT

A. Bolts associated with sanitary utility sewer installation shall be applied with anti-seize lubricant such as Never-Seez, or equal, prior to installation.

2.3 CONCRETE STRUCTURES

A. Construct manholes, catchbasins, and cleanouts as shown on the drawings.

2.4 PLASTIC PIPE

A. Acrylonitrile-Butadiene-Styrene (ABS) Pipe
   1. Pipe shall be manufactured from virgin rigid ABS compounds with a minimum cell class of 42222 as identified in ASTM 3965.
   2. Conform to ASTM D2661 for Schedule 40/DWV ABS pipe.

B. ABS Fittings
   1. Fittings shall be manufactured from virgin rigid ABS compounds with a minimum cell class of 42222 as identified in ASTM 3965.
   2. Conform to ASTM D2661 for Schedule 40/DWV ABS fittings.

C. Sanitary Sewer Couplings
   1. Couplings shall meet AASHTO M252, AASHTO M294, and AASHTO MP7; gaskets shall meet ASTM F477.
   2. 4- to 48-inch couplings shall be watertight and capable of passing full 10.8 psi ASTM D3212 lab testing. Joints shall remain watertight when subjected to a 1.5 degree axial misalignment.

D. High-density polyethylene (HDPE) Pipe
   1. Shall have a minimum pressure class 200 psi (SDR-11)
   2. Conform to ASTM D2737

2.5 BEDDING MATERIAL

A. Bedding shall be as specified in Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

3.2 EQUIPMENT

A. Equipment necessary and required for the proper construction of sanitary sewers shall be in good condition to perform the work.

B. Provide appropriate hoisting equipment to handle pipe in unloading and placing in its final position without damage to the pipe.

C. Provide such hand tampers and pneumatic tampers to obtain the specified compaction of the pipe bed and backfill.

3.3 LAYING PIPE

A. General:
   1. Inspect pipe for defects prior to laying. Replace defective pieces at no added cost to the Contractor.
   2. Lay pipe carefully true to lines and grades on a uniformly firm bed throughout its length.
   3. Pipe which shows undue settlement, is not in true alignment, or is damaged shall be taken up and relaid at no added cost to the Contractor.

4. Carefully clean pipe ends and fittings before laying. Keep pipe ends plugged prior to making connections.
5. Prevent foreign material (including clothing, tools, debris, etc.) from entering the pipe at all times.
6. Take adequate precautions to prevent any uplift from occurring to pipe during any interruptions in laying.
7. Prepare trench to give pipe full length support.
8. Lower and center pipe in final position.
9. Laying pipe on blocks not permitted.
10. Cut pipe only to remove defective ends, to allow insertion of fittings, or to obtain specified lengths.
11. Anchor bends involving unbalanced pressures with thrust blocks, as shown or directed.

B. Plastic Pipe
1. Install in accordance with ASTM D2321 and per pipe manufacturer's recommendations.
2. O-Ring Joints: Align joint and push home utilizing a well-lubricated gasket. Ensure bedding material is not pulled into the bell.
3. Avoid construction traffic over pipe.

C. Tolerance: Maximum deviation from true line or grade, as established, shall not exceed 1/2 inch for line and 1/4 inch for grade, provided that such variation does not result in a level or reverse sloping invert. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness.

D. Backfilling: See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

3.4 CONNECTIONS

A. Make connections to existing or proposed structures watertight and smooth for a uniform flow line throughout sewer system.

B. Grout connections.

3.5 UTILITY STRUCTURES

A. Install as shown on the drawings.

3.6 UTILITY WARNING TAPE

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

3.7 SANITARY SEWER SYSTEM TESTING

A. Notify the Port 48 hours prior to conducting tests.

B. Test only after all connections, manholes, backfilling, and compaction is complete between the stations to be tested.

C. Flush and clean prior to testing and final acceptance.

D. Hydrostatic or air test all gravity sewers prior to acceptance.
   1. Hydrostatic Test
   2. Air Test
      a. Conform to City of Portland Standard Specifications requirements.

E. Hydrostatic test all pressure sewers (force mains) in accordance with AWWA C600, unless otherwise directed.
   1. Hydrostatic Test
      a. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section.
      b. Test shall be at least 2 hours, minimum, duration.
      c. Test pressure shall not vary by more than + 5 psi.
      d. Allowable leakage:

$$L = SD(P)1/2/133, 200$$

Where:

L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure during the test, in pounds per square inch

F. Repair or replace equipment, materials, or piping found to be defective and/or unsatisfactory.

3.8 TELEVISION INSPECTION

A. Notify the Port and Contractor when all sewer construction, repairs, and testing is complete. Allow the Port and Contractor to witness television inspection and supply the Port with a video recording of the television inspection.

B. If required by the local jurisdiction, the Subcontractor shall perform a television inspection of the sewer at no additional cost to the Contractor.

C. Repair all deficiencies revealed by televiewing at no additional cost to the Contractor.

3.9 FLUSHING AND CLEANING

A. Clean thoroughly prior to final acceptance.

B. Flush, if directed.

3.10 ABANDONMENT OF EXISTING PIPES, MANHOLES, AND APPURTENANCES

A. Completely remove all pipe, manholes and appurtenances indicated on the drawings.

END OF SECTION 33 31 00

SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the installation of storm drainage piping and related structures.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03 30 00, Cast-In-Place Concrete

B. Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

1.3 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials
   1. AASHTO M36: Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
   2. AASHTO M167: Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
   3. AASHTO M190: Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
   4. AASHTO M196: Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
   5. AASHTO M252: Standard Specification for Corrugated Polyethylene Drainage Pipe
   6. AASHTO M294: Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
   7. AASHTO MP7: Standard Specification for Corrugated Polyethylene Pipe, 1350 and 1500 mm Diameter

B. ASTM: American Society for Testing and Materials
   1. ASTM A74: Standard Specification for Cast Iron Soil Pipe and Fittings
   2. ASTM A746: Standard Specification for Ductile Iron Gravity Sewer Pipe
   3. ASTM A760: Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
   4. ASTM C14: Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
   5. ASTM C33: Standard Specification for Concrete Aggregates
   6. ASTM C76: Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
   7. ASTM C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
   8. ASTM C150: Standard Specification for Portland Cement
   9. ASTM C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
   10. ASTM C595: Standard Specification for Blended Hydraulic Cements

11. ASTM C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
12. ASTM D1056: Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
13. ASTM D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
14. ASTM D2751: Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
15. ASTM D3212: Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
16. ASTM D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
17. ASTM D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity
18. ASTM D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
19. ASTM D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile
20. ASTM F477: Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. AWWA: American Water Works Association
   1. AWWA C600: Installation of Ductile Iron Water Mains and Their Appurtenances

D. CISPI: Cast Iron Soil Pipe Institute

E. ODOT: Oregon Department of Transportation – Standard Specifications
   1. ODOT RD 326: Coupling Bands for Corrugated Metal Pipe Types A, B, D, & E

1.4 SUBMITTALS/CERTIFICATIONS

A. Submit certifications showing that materials meet the requirements shown on the drawings and as specified below.

PART 2 - PRODUCTS

2.1 GROUT

A. Shall be non-shrink, non-ferrous, non-epoxy with a minimum design strength of 5,000 psi in 28 calendar days.

B. Use according to manufacturer’s recommendations.

2.2 ANTI-SEIZE LUBRICANT

A. Bolts associated with storm utility drainage installation shall be applied with anti-seize lubricant such as Never-Seez, or equal, prior to installation.

2.3 CONCRETE DRAINAGE STRUCTURES

A. Construct manholes, catch basins, and cleanouts as shown on the drawings.

2.4 STORM DRAINS

A. Corrugated High Density Polyethylene (HDPE) Pipe
   1. 3-inch through 10-inch: Conform to AASHTO M 252, Type S.
   2. 12-inch through 48-inch: Conform to AASHTO M 294, Types S and D.
   3. 54-inch through 60-inch: Conform to AASHTO MP 7, Types S and D.
   4. Perforated: Perforate pipe with two rows of 3/8 inch holes located approximately 60 degrees off the bottom on each side, spaced 3 inches on center in accordance with AASHTO M 294 and MP 7 Class II.

B. Storm Sewer Couplings
   1. For pressure-testable installations: Couplings shall meet AASHTO M 252, AASHTO M 294, and AASHTO MP 7; gaskets shall meet ASTM F477.
   2. 4- to 48-inch couplings shall be watertight and capable of passing ASTM D3212 lab testing at a modified 3.5 psi pressure. Joints shall remain watertight when subjected to a 1.5 degree axial misalignment.
   3. For non-pressure installations (culverts only): Soil tight couplings and fittings shall meet AASHTO M 252, AASHTO M 294, or AASHTO MP 7. Gaskets shall meet ASTM F477, be installed at the manufacturer's facility, and be covered with a removable wrap to ensure gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

C. Fittings
   1. Fittings shall conform to AASHTO M 252 or M 294. Fabricated fittings, where accessible, shall be welded on the interior and exterior at all junctions.

2.5 CONTAINMENT DRAINS

A. Approved Manufacturers:
   1. Isco Industries.
   2. Driscopipe.
   3. Plexco.
   4. Or Contractor-approved equivalent.

B. Follow the manufacturer's recommended installation guidelines unless stated otherwise.

C. Furnish pipe of materials, wall type, joint types, and sizes as indicated or specified. Furnish maximum pipe lengths produced by the manufacturer.

D. Pipe shall be DR-17, Pressure Class 100.

E. Materials:
1. Requirements: Made from a high density, extra high molecular weight material with a broad range molecular weight distribution designated as PE 4710 per FM 1613 with ASTM D3350 cell classification number of 445474C.
2. Cell classification description:

Cell Classification	Property	Cell Classification Limits
4	Density per ASTM D1505, gm/cm3	0.955 - 0.957
4	Melt index per ASTM D1238, gm/10 min	0.10 to 0.15
5	Flexural modulus per ASTM D790, psi	110,000 - 140,000
4	Tensile strength per ASTM D638, psi	3200 min
7	Pent per ASTM F1473, hours	>100
4	Hydrostatic Design Basis @ 73°F per ASTM D2837, psi	1600 min
C	Color and Ultraviolet Stabilizer	Black 2 to 2.5% Carbon Black

F. Manufacturing Requirements:
1. Made from virgin material, or from rework compound obtained from the manufacturer's own production of the same formulation.
2. Manufactured to ASTM F714.

G. Containment Drain Fittings
1. Same pressure class and cell classification as piping.
2. Molded or fabricated.
3. Elbows, straight and reducing tees, reducers, and stub ends shall be factory-fabricated with plain ends for butt fusion per ASTM D3261.
4. Installation guidelines shall follow manufacturer's recommendations unless stated otherwise.

2.6 ECCENTRIC PLUG VALVES:

A. Acceptable Manufacturers:
1. DeZurik, a unit of General Signal Corporation.
2. Henry Pratt Company.
3. Milliken Valve Company, Inc.
4. Val-Matic Valve and Manufacturing Corporation.
5. Victaulic Company of America

B. Design:
   1. Quarter-turn nonlubricated eccentric type with resilient faced plug. Valves with vane type seat rings are not acceptable. Shutoff up to scheduled rating with pressure in reverse direction where scheduled.
   2. Valves shall be buried 100% Port Eccentric Plug Valve with Actuator and Post and Indicator
   3. Flanged valve ends shall be faced and drilled to conform to ANSI B16.1, Class 125 for thickness and drilling.
   4. Mechanical or push-on type rubber-gasketed joint ends shall conform to AWWA C111.
   5. Screwed ends shall be to the NPT standard.
   6. Grooved ends shall conform to AWWA C606 rigid joint specifications.
   7. Port areas for valves through 20-inch shall be at least 100% of full pipe area.
   8. Plugs shall be eccentric type with no backing ring or frame.
   9. Valve body cavity shall be smooth without protrusions or baffles.

C. Materials and Construction:
   1. Bodies shall be of ASTM A126, Class B cast iron.
   2. Valve plug shall be ASTM A126, Class B cast iron or ASTM A536 ductile iron. Resilient plug facing or replaceable style body seats shall be synthetic nitrile rubber, and Jet A fuel resistant.
   3. Seat rings shall be threaded, or welded of corrosion-resistant 18-8 stainless steel, nickel, or Monel conforming to AWWA C504. Sprayed or plated mating seat surfaces are not acceptable.
   4. Bearings shall be replaceable. Sleeve type and thrust bearings in the upper and lower journals shall be corrosion-resistant stainless steel or bronze.
   5. Shaft seals shall be multiple O-ring, self-adjusting U-cup or chevron type packing conforming to AWWA C504. Pull-down packing is not acceptable.
   6. Shaft seals shall be field adjustable or replaceable without valve disassembly.
   7. All exposed fastening hardware shall be zinc plated or stainless steel. Provide stainless steel for buried service.

D. Actuators:
   1. Manual Actuators:
      a. All valves shall open counterclockwise.
      b. Provide indicators to show position of plug except on buried actuators.
      c. Worm gear actuators shall be totally enclosed, grease sealed, gear type furnished with AWWA nut, crank, handwheel, or chainwheel. All buried valves shall be provided with worm gear actuators, AWWA nut, and enclosed cover plate. All valves with reverse pressure capacity requirement shall be provided with worm gear actuators. Worm gear actuators shall be self-locking at all variable opening positions and sized to meet the torque ratings of AWWA C517. The shaft in a worm gear actuator shall have a nonmetallic or bronze sleeve type bearing. Submit manufacturer's parts and materials drawings.
      d. Handwheels shall be located in positions indicated or as otherwise determined when manufacturer's drawings are submitted.
   2. Valve Controls:
      a. Operate valve actuator to perform control function required.
         1) Open or close valve.

3. Shop Painting: Apply interior coating conforming to AWWA C550 to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550.

2.7 BEDDING MATERIAL

A. Bedding shall be as specified in Section 31 20 01, Site Preparation and Earthwork – Fuel Systems

2.8 GASKETS AND BOLTING MATERIALS:

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings and specials complete and ready for service.

B. Provide all necessary gaskets and adapters to transition HDPE piping to selected eccentric plug valves.

C. All gaskets installed on containment drain piping shall be resistant to Jet Fuel A. Gaskets for flanged joints shall conform to AWWA C115, 1/8-inch thick, full-face synthetic rubber.

D. Bolts for flanged joints shall conform to ASTM A307, Grade B. Nut and bolt heads shall be hexagonal.

E. Gaskets and bolts for other than flanged joints shall be as otherwise specified for pipe and pipe joints.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems .

3.2 EQUIPMENT

A. Equipment necessary and required for the proper construction of storm sewers shall be in good condition to perform the work.

B. Provide appropriate hoisting equipment to handle pipe in unloading and placing in its final position without damage to the pipe.

C. Provide such hand tampers and pneumatic tampers to obtain the specified compaction of the pipe bed and backfill.

3.3 LAYING PIPE

A. General:
1. Inspect pipe for defects prior to laying. Replace defective pieces at no added cost to the Contractor.
2. Lay pipe carefully true to lines and grades on a uniformly firm bed throughout its length.
3. Pipe which shows undue settlement, is not in true alignment, or is damaged shall be taken up and relaid at no added cost to the Contractor.
4. Carefully clean pipe ends and fittings before laying. Keep pipe ends plugged prior to making connections.
5. Prevent foreign material (including clothing, tools, debris, etc.) from entering the pipe at all times.
6. Take adequate precautions to prevent any uplift from occurring to pipe during any interruptions in laying.
7. Prepare trench to give pipe full length support.
8. Lower and center pipe in final position.
9. Laying pipe on blocks not permitted.
10. Cut pipe only to remove defective ends, to allow insertion of fittings, or to obtain specified lengths.
11. Anchor bends involving unbalanced pressures with thrust blocks, as shown or directed.

B. Storm Drain Installation (Corrugated HDPE)
1. Install in accordance with ASTM D2321.
2. O-Ring Joints: Align joint and push home utilizing a well-lubricated gasket. Ensure bedding material is not pulled into the bell.
3. Avoid construction traffic over pipe.

C. Containment Drain Installation (Smooth-Walled HDPE)
1. Containment drain HDPE piping or fitting connections to other HDPE pipe or fittings shall be fusion-welded in accordance with manufacturer's recommendations.
2. Furnish special fittings or adapters as required to join two pipes, fittings, or accessories of dissimilar material.

D. Eccentric Plug Valve Installation
1. Install per manufacturer recommendations.

E. Tolerance: Maximum deviation from true line or grade, as established, shall not exceed 1/2 inch for line and 1/4 inch for grade, provided that such variation does not result in a level or reverse sloping invert. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness.

F. Backfilling: See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems .

G. Perforated Plastic Pipe Underdrain
1. Install in accordance with ASTM D2321 and as shown on the drawings.
2. Lay with perforations facing down, unless otherwise directed.
3. Carefully lower pipe and fittings into the trench to avoid contaminating filter material.

3.4 CONNECTIONS

A. Make connections to existing or proposed structures watertight and smooth for a uniform flow line throughout drainage system.

B. Provide 36-inch diameter or smaller concrete sewer pipes that enter or leave manholes or other structures with flexible joints within 18 inches of the exterior wall.

C. Concrete pipes larger than 36 inches in diameter shall have a flexible joint within a distance from the exterior wall equal to one half the inside pipe diameter.

D. Grout connections.

3.5 UTILITY STRUCTURES

A. Install as shown on the drawings.

3.6 UTILITY WARNING TAPE

A. See Section 31 20 01, Site Preparation and Earthwork – Fuel Systems .

3.7 CONTAINMENT DRAIN SYSTEM TESTING

A. Notify the Port 48 hours prior to conducting tests.

B. Test only after all connections, manholes, backfilling, and compaction is complete between the stations to be tested.

C. Flush and clean prior to testing and final acceptance.

D. Hydrostatic or air test all containment drains prior to acceptance.
   1. Hydrostatic Test
      a. Fill with water to a level at least 6 feet above crown of pipe.
      b. Any system leakage must be corrected.
   2. Air Test
      a. Conform to local jurisdiction requirements.

E. Eccentric Plug Valves Testing
   1. Furnish certified copies of results of tests prior to shipment. All valves shall be subjected to an AWWA C504 procedure cycle life and pressure leak test at 1034 kPa (150 psi) and a body hydrostatic test at 2068 kPa (300 psi). Valves shall be capable of providing drip-tight shutoff up to the full leak test rating. Certify reverse pressure capacity.

F. Repair or replace equipment, materials, or piping found to be defective and/or unsatisfactory.

3.8 TELEVISION INSPECTION

A. Notify the Port when all sewer construction, repairs, and testing is complete.

B. If required by the local jurisdiction, the Subcontractor shall perform a television inspection of the sewer at no cost to the Contractor.

C. Repair all deficiencies revealed by televiewing at no cost to the Contractor.

3.9 FLUSHING AND CLEANING

A. Clean thoroughly prior to final acceptance.

B. Flush, if directed.

3.10 ABANDONMENT OF EXISTING PIPES, MANHOLES, AND APPURTENANCES

A. Completely remove all pipe indicated on the drawings. Remove all manholes and appurtenances to an elevation at least 2 feet below subgrade.

END OF SECTION 33 41 00

SECTION 33 47 13 – FLEXIBLE MEMBRANE LINER

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Contract Provisions, Special Provisions, Supplementary Conditions, and other DIVISION 1 Specifications apply to this Section.

1.02 SUMMARY

A. The Work includes furnishing and installing impervious membrane liner material for secondary containment areas as shown on the drawings and as specified in these Special Provisions and the membrane liner fabricator's approval shop drawings.

1.03 RELATED REQUIREMENTS:

1. Section 31 20 01 – Site Preparation and Earthwork – Fuel Systems

1.04 REFERENCE

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. D471 - Test Method for Rubber Property - Effect of Liquids.
   b. D751 - Coated Fabrics.
   c. D1149 - Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens).
   d. D1204 - Test Method for Linear Dimensional, Charges of Nonrigid Thermostatic Sheeting or Film at Elevated Temperature.
   e. D2136 - Low-Temperature Bend Test for Fabrics Coated with Rubber and Rubber-Like Materials.
   f. D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.
   g. D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

1.05 SUBMITTALS

A. Unless liner manufacturer is pre-approved in this specification, manufacturer must submit a list of not less than 5 projects totaling not less than 10 million square feet of fuel containment projects in service with the material specified in this section.

B. Manufacturer's certification that materials comply with requirements.

C. Manufacturer's certification that liner Installer is approved or licensed to install manufacturer's liner.

D. Qualifications certifying liner Installer has successfully installed at least 5 completed projects with a combined total of 1 million square feet of reinforced smooth or textured membrane liner.

E. Manufacturer's standard catalog information and specifications, installation instructions, and general recommendations from membrane materials manufacturer for type of membranes required.

F. Warranty to be submitted to Owner.

G. Shop drawings indicating location of field-fabricated joints, methods of sealing to other structures, and openings through liner.

H. The fabricator of liner used in this work must prepare shop drawings with a proposed panel layout to cover the liner area shown in the project plans. Shop drawings must indicate the

direction of factory welds and must show panel sizes consistent with the material quantity requirements of 1.01.

I. Details must be included to show the termination of the panels at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring.
J. Samples of fabricated liner material 8 inch x 8 inch size.
K. Samples of factory and field jointed fabricated liner.
L. Fuel resistant sealant.
M. Provide liner installer's quality control manual to include, but not be limited to, seam sampling, testing, and documentation of all installation and testing activities required by these Specifications.
N. Within 30 working days after date of geomembrane installation is complete, submit as-constructed drawings showing:
    1. Numbered panels.
    2. Numbered seams.
    3. Destructive test sample locations.
    4. Patches and repairs.

    The as-constructed drawings must be referenced to the coordinate system shown on the Contract Drawings

1.06 QUALITY ASSURANCE:

A. Membrane conformance test data and membrane manufacturer quality control testing must meet or exceed requirements of this Section prior to installation. Materials that do not conform to these requirements must be retested or rejected at the direction of Engineer.
    1. Membrane that is rejected must be removed from the Project Site and replaced at Subcontractor's expense. Sampling and conformance testing of membrane supplied to replace rejected material must be performed by Engineer at Subcontractor's expense.
B. Provide a Construction Quality Assurance (CQA) program. One or more CQA Monitors must be on-site during liner installation.
C. Liner Installer must provide one or more Construction Quality Control (CQC) Managers to monitor installation, testing, and documentation of liner installation. CQA Monitor and CQC Manager will coordinate all activities relating to the installation, testing, and documentation.
    1. Installation documentation must be recorded by the CQC personnel.

1.07 OPERATING CONDITIONS:

1. Membrane material will be exposed to direct sunlight and ultraviolet rays during the service life.
2. Ambient air temperatures at Site location to range from -3ºF to 116ºF.

1.08 DELIVERY, STORAGE AND HANDLING:

A. Receive, store, and handle geomembrane lining materials as recommended by manufacturer. Cover all materials completely while stored on Site prior to use.
B. All welding material must be delivered in the original sealed containers, each with a permanent label bearing the brand name, manufacturer's mark number, and complete directions for storage.
C. Damaged material on rolls must be cut out and removed from the Site.
D. Stack geomembrane a maximum of five rolls high.

1.09 WARRANTY

A. Furnish a written warranty from the membrane manufacturer for a useful life of not less than 10 years from the date of installation, covering the membrane liner material under the specified operating conditions.

B. Such written warranties must provide for the repair and/or replacement of any defect or defective areas of membrane, or compensation for defective work, upon written notification and demonstration by Owner of the specific non-conformance of the membrane or installation with the Contract Specifications. Compensation for defective material must be provided to Owner on a pro rata basis for the estimated cost to Owner at that time of supplying and installing material to a clean, dry, and unencumbered condition by a third-party installer.

C. Subcontractor is responsible for obtaining any necessary guarantees or certifications from membrane manufacturer and membrane Installer and submitting them to Engineer and Owner prior to installation of geomembrane liner.

D. Furnish as a minimum, a 1-year, non-pro-rata warranty from the membrane Installer for the installation against defects. Within this warranty period, the Installer must replace or repair at no additional cost to the Owner, defective materials and workmanship including leakage, abnormal aging or deterioration of materials, and other failures of membrane lining to perform as required.

PART 2 - PRODUCTS

2.01 GENERAL

A. All lining materials must be first-quality, nonrecycled products designed and manufactured specifically for the purpose of containing Jet A fuel spills.

B. Lining must consist of sheeting fabricated into large sections by means of factory joints into the minimum number of large pieces required to fit facility.

C. Lining must be suitable for ultraviolet exposure and installation to steel walls.

D. Include with liner all items necessary for complete installation including adhesive, anchoring bars and bolts, pipe shrouds, clamps, etc.

E. The liner must be fuel and oil-resistant flexible liner with hydrocarbon Jet A fuel resistance characteristics, with or without fabric reinforcement.

F. The manufacturer of the lining material must have a minimum of ten years of proven experience in the manufacture and shop assembly of the lining for field installation.

2.02 LINER MATERIAL

A. Seaman XR-5 Liner Material 8130, or Engineer-approved equal material:

1. Properties:
    a. Base material - Polyester Fabric.
    b. Fabric weight - 6.50 oz./sq. yd. minimum.
    c. Finished thickness - 30 mils minimum.
    d. Finished coated weight: ASTM D751 30+2 oz/sq. yd. minimum.
    e. Tensile strength grab lbs.: ASTM D751 550 x 550 lb. min.
    f. Percent elongation @ yield (%) – 20% min.
    g. Tear strength trapezoidal, ASTM D4533 40/55 lb. minimum.
    h. Hydrostatic resistance: ASTM D751 (Method A Proc. 1) 800 psi min.

i. Puncture resistance: ASTM D4833 275 lb. min.
j. Bursting strength: ASTM D751 (Ball tip) 750 lb. min.
k. Bonded seam strength as modified by NSF5Y: (Grab Test Method, Procedure A): ASTM D751 550 lb. min.
l. Dimensional stability: ASTM D1204, 212ºF for 1 hour, 0.5% maximum.
m. Coefficient of Thermal Expansion - Contraction: ASTM E228, 8 x 10^{-6} in/in/ ºF maximum.
n. Dead Load Seam Strength: ASTM D751 2-inch overlap seams, 4 hours. 240 lbs load minimum at 70ºF.
o. Water Absorption: ASTM D-471, 7 days: 5% max. @ 70°F, 12% max. @ 212°F
p. Abrasion Resistance (Taber Method, Method 5306: Fed, Std. 191a, H-18 Wheel, 100g load, 2000 cycles before fabric exposure, 50mg/100 cycles max. wgt. loss
q. Permeability: ASTM D814-55, Kerosene 0.02 oz./SF/Day max. And Transformer Oil with PCB Contamination
r. Hydrocarbon Resistance : Kerosene, JP, >95% Tensile strength retention with no stiffening (75 moth constant immersion)
s. Transformer Oil Resistance : Univolt 60 (30 days immersion).>95% Tensile strength retention with no stiffening (30 days immersion)

B. Manufacturers:
1. Seaman Corporation (8130) XR-5.
2. Engineer Approved Equal.

2.03 ANCHORING MATERIALS

A. Prefabricated Embedded Anchor Strip: Use when anchoring to concrete structures, unless indicated otherwise.
1. Embedded strip must be extruded from material having the same chemical resistancy and durability as the liner.
2. Embedded strip must be fully compatible for welding to the liner.
3. Embedded strip must be 3-inch wide minimum, with at least three 1-inch long anchoring fingers for embedding into concrete.

B. Stainless Steel Batten Bar: Use when securing to steel structures as indicated.
1. Provide 1/4-inch thick by 2-inch wide Type 304 or 316 stainless steel bars.
2. Provide pre-punched bolt holes in the strip at maximum 12 inches on center to accommodate the concrete anchor bolts.
3. Anchoring bolts must be wedge-type concrete anchors of Type 304 or 316 stainless steel, 3/8-inch diameter (minimum) and length as indicated. If not indicated, provide length as required for sufficient installation to steel structure.
4. Bolt spacing must be at 12 inches on center maximum, unless indicated otherwise. Provide each anchor bolt with stainless steel nuts and washers conforming to ASTM A194/A194M, Grade 8.
Gasket: Provide a minimum 1/4-inch thick by 2-inch wide compressible medium density closed cell sponge 100% pure nitrile gasket on one or both sides of the geomembrane as indicated at mounting strip locations to seal and protect the geomembrane and mounting strip.

2.04 MISCELLANEOUS MATERIALS:

A. Provide types of adhesive compounds and tapes recommended by liner manufacturer for bonding to structures, sealing of seams in membrane, and sealing projections through liner, and is resistant to jet fuel.
B. Provide liner fittings (for example, boots and sleeves) that are factory prefabricated components produced from the same manufacturer that produces the fuel impermeable liner. Fittings must have the same fabrication characteristics as the liner.
C. Band clamps for use around pipe penetrations must be stainless steel.
D. Joint Sealant: Joint sealant must be fuel resistant and must conform to ASTM C920, Type S or M, Grade NS, Class 25.

2.05 WELDING EQUIPMENT:

A. Supply seam welding accessories meeting the following requirements:
   1. Maintain sufficient operational seaming apparatus to continue work without delay.
   2. Use a power source capable of providing constant voltage under combined line load.
   3. Provide a protective lining and splash pad large enough to catch spilled fuel under the power generator, if located on the geomembrane liner.
   4. Provide tensiometers capable of measuring seam strength, calibrated and accurate to within 2 pounds.

2.06 FABRICATION

A. Manufacturer liner sheets in as large a width as possible to minimize seaming.
B. Fabricate liner membrane in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures.
C. Factory seams must be made with a 2-inch overlap plus or minus 1/4-inch by an automatic thermal high pressure welding process.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Receive, store and handle membrane liner materials as recommended by liner manufacturer.
B. Place impervious membrane liner in such a manner as to minimize handling. Follow installation procedures as recommended by liner manufacturer.
   1. Seal liner to all concrete structures, pipes, openings and lining joints to prevent leakage.
   2. Do not install liner on wet or frozen subgrade or structures.
   3. Use lapped and sealed joints in field, matching factory-fabricated joints. Form lapped joints by lapping edges of pieces 2 inches to 4 inches, unless larger overlap recommended by liner manufacturer. Wipe contact surfaces of pieces clean and free of dirt, dust, moisture, or other foreign materials. Use solvent cleaning methods when recommended by liner manufacturer. Field splices must be made by using thermal seaming process approved by liner manufacturer.
   4. Provide allowance for shrinkage and wrinkling of the field panels. Roll as required to remove wrinkles.
   5. Carefully inspect seams and reseal voids.
      a. Field joints must be when the ambient air temperature is less than 35^{o}F.
      b. Field joints are not allowed during any rainfall.

6. Field Overlap for Filter Fabric:
    a. Fabric surfaces to be overlapped must be clean before overlapping.
    b. Provide overlap of fabric panels of 12 inches minimum.
7. While working on or near the filter fabric:
    a. No smoking shall be allowed.
    b. No glass or metal containers or other sharp objects shall be used.
    c. No construction installation equipment shall pass over any exposed fabric surface.
    d. Remove water from the surface prior to fabric installation.
8. All liner-to-concrete joints must be sealed and anchored as indicated.
9. Jointing of the liner to pipes must consist of sealer, liner shroud and stainless steel clamps.

C. Embedment Strip Installation: Install embedment strips in cast-in-place concrete structures using methods and materials recommended by the embedment strip/liner manufacturer. Extrusion weld all joints and intersections of embedment material together or otherwise join as recommended by the manufacturer to provide a continuous surface for attachment of the liner. Fill any holes through the face of the embed material resulting from the concrete forming or placement process with material recommended by the manufacturer.

D. Anchorage to Concrete: Install prefabricated embedded anchor strip in concrete. Clean contact surfaces of liner and anchor strip. Attach liner to anchor strip using thermal seaming process approved by liner manufacturer.

E. Repair or replace, as directed by Owner's Representative, areas of liner showing injury from scuffing, penetration by foreign objects, distress from rough subgrade, or other unacceptable conditions.

F. Repair tears, punctures, and other imperfections in liner fabric using patches of liner material itself and bonding methods recommended by liner fabric manufacturer. Repairs must be made using heat welding methods. Roll as required to remove any wrinkles. For reinforced membranes, seal exposed fabric edges with a 3-inch wide nonreinforced tape of liner fabric.

G. Protect installed liner in accordance with liner manufacturer's instructions.

H. Provide qualified factory technician to supervise the assembly and installation of liner, as necessary to obtain warranty conditions.

3.02 FIELD QUALITY CONTROL

A. Provide qualified factory technician to supervise the assembly and installation of liner, as necessary to obtain warranty conditions.

B. Provide a quality assurance certification regarding field installed material.

C. Provide vacuum box testing of all field-installed seams. Owner's Representative must witness test.

D. Perform a test field seam a minimum length of 5 feet and joint test performed. Test must be performed for each day's work.

E. After successful completion of the liner vacuum box test, perform an air lance test on seams not testable with a vacuum box test (for example, small seams around penetrations, oddball types of patches, etc.) to detect an unbonded area.
    1. Perform the test using a minimum 50 psig jet of air regulated and directed through a 3/16-inch diameter nozzle.

2. Apply the jet of air to the lip of a seam in a near perpendicular direction to the length of the seam.
3. Hold the nozzle a maximum of 4 inches from the seam and travel at a rate of not to exceed 40 fpm.
4. Inflation of any section of the seam by the impinging air stream must be indicative of an unbonded area. Unbonded areas must be repaired and retested.
5. Perform repairs in accordance with manufacturer's recommendations.

F. Liner terminated with batten bars must be tested using air lance test described above prior to application of joint sealant.

G. The CQA Monitor or Owner may require additional random samples be taken for destructive testing in areas that visually appear defective or not in conformance with these Specifications. Testing of these samples must be completed by CQA Monitor, but obtaining the samples and repairing the sample areas must be the responsibility of CQC Manager.

H. A final visual examination of all welds and in-place geomembrane will be completed by CQA Monitor.
1. Repair, in accordance with these Specifications, any area designated by CQA Monitor as not in accordance with the Specifications.
2. Subcontractor must be responsible for cleaning, sweeping, or other measures necessary to provide a thoroughly visible geomembrane surface for CQA Monitor's inspection.
3. CQA Monitor's inspection will be performed following a complete inspection and approval by Contractor's designated quality control technician.

END OF SECTION 33 47 13

SECTION 33 52 43 - FUEL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Furnish all labor, equipment, and material for the complete installation of the aircraft fueling system indicated and specified.

B. Unless otherwise specified, all items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with maximum operating condition of 275 psig, within a temperature range of -20ºF to 100ºF, and having a specific gravity of 0.81 ±0.05.

1.03 RELATED REQUIREMENTS:

A. Section 01 33 00 - Submittals.
B. Section 25 30 01 - Instrumentation for Fuel Systems.
C. Section 25 50 01 - Facility Controls for Fuel Systems.
D. Section 25 90 01 - Control Sequences for Fuel System.
E. Section 31 20 01 - Site Preparation and Earthwork.
F. Section 33 52 44 - Identification of Fuel Piping and Equipment.
G. Section 33 52 45 - Fuel System Pipe, Connections, and Installation.
H. Section 33 52 46 - Fuel System Coatings for Corrosion Protection.
I. Section 33 52 47 - Fuel System Valves.
J. Section 33 52 48 - Fuel System Accessories.
K. Section 33 52 50 - Fuel System Pumps.
L. Section 33 52 51 - Fuel System Filtration.
M. Section 33 52 53 - Inspection, Testing and Flushing.
N. Section 33 52 41 - Shop Fabricated Aboveground Storage Tanks.
O. Section 33 56 43 - Fuel System Aboveground Storage Tanks (Field Fabricated).
P. Section 33 56 45 - Aboveground Oil Water Separator.
Q. All control and instrumentation provisions for fuel systems shall be accomplished under the direction of the qualified control system Subcontractor described in Section 25 50 01.

1.04 REFERENCE STANDARDS:

A. Refer to the individual Sections for fuel systems.
B. American Society of Mechanical Engineers (ASME):
   1. B31.3 - Process Piping.
   2. Boiler and Pressure Vessel Code (BPVC), Section I - Rules for Construction of Power Boilers.
   3. Boiler and Pressure Vessel Code (BPVC), Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.

1.05 SUBMITTALS:

A. Submit as specified in Section 01 33 00.
B. Prior to submission, verify all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data are in compliance with the Contract Documents and can be installed, operated, and maintained in the allocated space.

C. Include, but not limited to, the following:
   1. Piping fabrication drawings.
      a. Include in-plan view of all systems piping 2 1/2 inches and larger. Provide isometrics for piping systems or tubing 2 inches in diameter and smaller.
      b. Show the actual Equipment furnished, Equipment location by dimension, and connections.
      c. Dimension pipelines in plan view and locate in elevation. Indicate support locations.
      d. Submit before beginning fabrication.
      e. The pipe routing and supports indicated are within the stress limits of ASME B31.3. Changes in piping configuration resulting from Subcontractor's selection of Equipment, or a preferred method of pipe routing, will require detailed stress analysis. For changes in the design documents by Subcontractor, stress analysis and support design shall be reanalyzed for all anticipated loads including gravity, thermal, pressure, and seismic in accordance with ASME B31.3. These calculations shall be performed and stamped by an Oregon-registered Professional Engineer and submitted as Submittals for review by Engineer.
   2. Concrete Foundations: Submit detailed drawings which include the following information:
      a. Plan size, height, configuration, and top elevation of foundation.
      b. Location of each Equipment foundation dimensioned to a common reference point.
      c. Equipment anchor bolt location projection and dimensions.
      d. Type, size, and length of anchor bolts.
      e. Indicate reinforcing steel and size.
      f. List Equipment manufacturer's reference drawing numbers used for anchor bolt location.
   3. Motors and Drives:
      a. List all motor nameplate data on drawings including full load amps, locked rotor amps, and service factor for the motor at the voltage specified.
      b. List operating brake horsepower of the Equipment furnished.
      c. Furnish dimensioned motor drawing.
      d. Provide drawings for shop or field fabricated guards.
   4. Hangers and Supports:
      a. Provide detailed drawings of support assemblies indicating the following:
         (1) Plan and elevation of piping.
         (2) Plan and elevation of support components.
         (3) Complete Bill of Materials.
         (4) Hanger/Support tag designation.
         (5) Erection requirements including field weld sizes and weld rod requirements.
         (6) Concrete pad, grout, and foundation details.
   5. Pumps, including performance curve and specified accessories.
   6. Filter Separators.
   7. Strainers.
   8. Manual and Motor-Operated Valves.
   9. Control Valves.
   10. Check Valves.
   11. Meters.
   12. Coating Materials.

13. Aboveground Storage Tanks: Indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
14. Pipe, Fittings, and Accessories including certificates of origin, material certificates and mill test reports.
15. Testing and Examinations:
    a. Pressure Testing Records.
    b. Nondestructive Examinations (NDE) Records.
    c. Qualifications of Examiners and NDE Personnel.
16. Welding qualifications and welder certificates signed by Contractor certifying that qualifications and welders comply with requirements specified under "Quality Assurance" Article.
    a. Welding Procedure Specification (WPS).
    b. Procedure Qualification Record (PQR).
    c. Welder Performance Qualification (WPQ).
17. Provide to Contractor a minimum of 30 days prior to delivery, the Installation, Operation, and Maintenance (IOM) manuals include, but are not limited to, the following:
    a. Isolating Flange Kits.
    b. Pipe Supports.
    c. Aboveground Storage Tanks.
    d. Pumps.
    e. Filter Separators.
    f. Strainers.
    g. Control Valves.
    h. Motor-Operated Valves.
    i. Manual-Operated Valves.
    j. Check Valves.
    k. Meters.
    l. Controlling Instruments.
    m. Pressure Gauges.
    n. Thermometers.
    o. Fittings and Specials.
    p. Installation and Erection Details.
18. Provide all instruction books and manuals complete in an organized, indexed electronic format (PDF). In addition, provide two complete indexed hard copies in three-ring binders with hard durable covers clearly and permanently identified with Contract name and number.
19. Each manual shall include the Equipment purchase order.
20. Refer to related Sections for further definition of submittal requirements.
21. Provide as-built profiles and piping plans along with as-built survey data used to develop the as-built profiles.

1.06 QUALITY ASSURANCE:

A. Acceptable Manufacturers: Specified in each Section of DIVISION 33.
B. All Equipment and Materials shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials.
C. When two or more units of the same class of Equipment are required, they shall be products of a single manufacturer.

D. Unless otherwise specified, low melting point and brittle materials (e.g., aluminum and cast iron) shall not be provided in fuel carrier Equipment and Materials.
E. Qualify welding processes and welding operators in accordance with ASME BPVC, Section IX.
F. All Subcontractor supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Receive, unload, check, and store in suitable facilities all Equipment and Materials.
B. Examine all Equipment and Materials for concealed damage and report any damage to Owner.
C. Be responsible for the safety and protection from loss or damage of all Equipment and Materials received until the Work is complete.
D. Installation means and methods shall not damage Materials and Equipment.
E. Protect all Equipment and Materials during storage and prior to start-up which shall include the coverings of all openings, protection against rust and other damage, and other similar measures. Equipment may be stored outdoors only when approved. Subcontractor shall protect all coated pipe and fittings from ultraviolet deterioration.
F. Furnish all labor, Materials, and Equipment necessary to make a complete installation as indicated and specified.
G. Provide all necessary supports, brackets, or foundations for properly installing all Equipment or temporary piping.
H. Coordinate with the other trades before installation of Materials. Extra charges shall not be approved for interferences due to lack of coordination.
I. All Equipment shall be properly aligned, adjusted, and lubricated before final acceptance.
J. Spot paint all Equipment where the shop paint has been damaged or flaked off. Finish painting of all piping and Equipment is specified in Section 33 52 46 unless otherwise specified. The factory coating of Equipment is not acceptable as the complete coating system unless provided in accordance with Section 33 52 46 and acceptable to the Owner.
K. Furnish all bolts, studs, nuts, and gaskets for makeup of all connections to the Equipment and replace all gaskets damaged during storage, inspection, cleaning, or placing into service.
L. Retighten all threaded and bolted connections after installation.
M. All Materials shall be installed at times necessary to avoid delays in construction.
N. All Work in existing buildings shall be done on a schedule as approved by Owner to assure minimum interruptions.
O. Provide vents and drains at high and low points where indicated, and as required elsewhere for satisfactory draining and venting of fuel systems. For above grade piping systems, high point vents shall match fuel high point vent detail in design drawings. Low point drains for above grade piping systems shall match fuel low point drain detail in design drawings.
P. All connections to valves 3 inches and larger shall be made with flanges, unless indicated otherwise; all connections to Equipment shall be made with unions or flanges.

Q. Piping indicated on the Drawings is partially diagrammatic and not necessarily the exact routing. Provide all necessary bends that may be required to avoid conflict and interferences. Bends required in addition to those indicated shall be submitted for approval by Engineer prior to fabrication.
R. Provide sleeves and flashings for all piping penetrating walls and slabs. Provide all required openings in walls and slabs.
S. Installation shall equal or exceed the minimum requirements of the applicable codes and these Specifications; however, where local codes and ordinances are more stringent, they shall govern.
T. Verify all measurements and location of existing facilities and underground piping before commencing Work.
U. Certain permanent and temporary piping and equipment systems shall be installed, inspected, tested, flushed, and placed into operation prior to complete installation of the Work. Provide all gaskets, companion flanges, bolting, weld caps, temporary blank-off plates, temporary piping systems, labor, materials, and accessories required to place these systems into operation.

3.02 PIPE TRENCH:

A. Excavation, backfill, and compaction of pipe trench shall conform to Section 31 20 01 of the Specifications.

3.03 WELDING QUALIFICATION AND APPROVAL:

A. The Welding Procedure Specifications (WPS) that are intended to be used on the job shall be submitted to Engineer for review prior to fabrication of the system piping.
B. Submit certified copies of the Procedure Qualification Records (PQR) as evidence that the intended procedures have been qualified in accordance with the latest revisions of the following codes:
    1. ASME B31.3.
    2. ASME BPVC, Section I and Section IX.
C. Design for the conditions of this Contract. Be complete and specific, and where necessary, differentiate between shop and field welding.
D. Welder Performance Qualification (WPQ) Test Certificates:
    1. Furnish Welder Performance Qualification test certificates for positions 2G and 5G or 6G, made in strict compliance with the above codes.
    2. Submit current qualification test records for each welder on the Project and keep record files current. Welder shall have been qualified to the WPS within the last six months.
    3. Welder Performance Qualification test certificates shall be submitted to Engineer before the welder shall be permitted to work on the Project.
    4. Welders shall be certified for the type of pipe material welded.
    5. Submit copies of the Welder Performance Qualification test certificates to Engineer for review as specified for Submittals.
    6. Welders and welding operators shall be qualified without the use of backing rings for all welding.
E. Submit WPS, PQR, and WPQ on the forms contained within Appendix B of the ASME BPVC, Section IX.
F. Submit each welders or welding operators' identification number or symbol with the WPQ. Welders or welding operators shall stamp their welds with their identification number or symbol.

3.04 FIELD TESTS:

A. Service and Test Engineers:
   1. Furnish the services of experienced factory service engineers for at least the minimum time specified and additional time as required to perform and/or supervise the erection, start-up, testing, and placing into successful operation all piping systems and Equipment, and to instruct Owner's personnel in the operation of Equipment.
   2. The service and test engineers required to conduct start-up and tests of the systems and Equipment furnished shall be called to the Site only after the installation is complete and ready, and Owner has been notified at least two weeks in advance.

B. Testing:
   1. Perform all tests as specified, recommended by the manufacturer, and required by the applicable codes. Additional tests deemed necessary by Owner shall be performed to ensure proper operation and function of the Equipment furnished, and to certify that the furnished Equipment meets the performance specified.
   2. Perform tests before Work is concealed and only after notifying Owner that items are ready. All tests shall be witnessed by Owner.
   3. Conduct tests in a safe and orderly manner with qualified trained personnel in accordance with safety codes and local ordinances.
   4. Obtain all necessary approvals, acceptances, and permits.
   5. Correct all deficiencies resulting from tests.
   6. Equipment and System Performance, and Acceptance Tests:
      a. Furnish all instruments, thermometers, and gauges required for testing. If the accuracy or completeness of installed instrumentation is not sufficient, Subcontractor shall provide additional instrumentation.
      b. Provide all pipe connections, valves, temporary connections, and lines as specified or as required for testing.
      c. Perform all performance tests as soon as practical after successful start-up operation to determine if the Equipment furnished meets the Specifications and guarantees.
      d. Notify Owner at least two weeks in advance before the test. Provide a written notice containing the test schedule, test procedure, and the personnel to be present at the test.
      e. Provide a typewritten report of the test, including all test log sheets, and submit to Owner as specified.
      f. Provide electrical power, water, and operating personnel for start-up, operating, and performance testing.
      g. In the event of failure of any Equipment or systems specified in this Contract to operate and perform as specified, or if the Equipment fails to meet the performance guarantees provided for in this Contract, Owner shall have the right to operate the system or Equipment until such defects have been remedied by Subcontractor, and the guarantees complied with. If defects necessitate the rejection of the system or Equipment, Owner shall have the right to operate the Equipment, without additional cost, until such time as new Equipment is provided to replace the rejected Equipment. Replacement of the Equipment shall be coordinated and scheduled with Owner.
   7. Tests and Checks of Piping Systems for Acceptance:
      a. Inspection, Testing, and Flushing shall be as specified in Section 33 52 53.

3.05 FACTORY TESTS:

A. For factory testing of Equipment, refer to specific Sections of DIVISION 33 where Equipment is specified.

END OF SECTION 33 52 43

SECTION 33 52 44 - IDENTIFICATION OF FUEL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the identification of fuel piping and equipment.

1.03 RELATED REQUIREMENTS:

A. Section 33 52 45 - Fuel System Pipe, Connections, and Installation.
B. Section 33 52 46 - Fuel System Coatings for Corrosion Protection.
C. Section 33 52 47 - Fuel System Valves.
D. Section 33 52 48 - Fuel System Accessories.
E. Section 33 52 50 - Fuel System Pumps.
F. Section 33 52 51 - Fuel System Filtration.
G. Section 33 56 41 - Shop Fabricated Aboveground Storage Tanks
H. Section 33 56 43 - Fuel System Aboveground Storage Tanks (Field Fabricated).
I. Section 33 56 45 - Aboveground Oil Water Separator

1.04 REFERENCE STANDARDS:

A. American Petroleum Institute (API):
   1. Recommended Practice (RP) 1637 - Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Gasoline Dispensing Facilities and Distribution Terminals.
B. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.
C. Energy Institute (EI):
   1. Standard (Std) 1542 - Identification Markings for Dedicated Aviation Fuel Manufacturing and Distribution Facilities, Airport Storage and Mobile Fuelling Equipment.
D. Federal Aviation Administration (FAA):
   1. Advisory Circular (AC) 150/5230-4B - Aircraft Fuel Storage, Handling, Training, and Dispensing on Airports.
E. National Fire Protection Association (NFPA):
   1. 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response.

1.05 SUBMITTALS:

A. Submit as specified in Section 33 52 43.
B. Include, but not limited to, the following:
   1. Proposed identification scheme including plans identifying proposed piping and equipment label locations.
   2. Catalog Cuts.
   3. Product Data.
   4. Sample(s) representative of labels specified.
   5. Color Chips.

1.06 QUALITY ASSURANCE:

A. Codes and Standards:
   1. Comply with listed Codes and Standards for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:
   1. Brady.
   2. Seton Nameplate.
   3. Gammon Technical Products.

B. Paint products shall be as specified in Section 33 52 46.

2.02 IDENTIFICATION OF PIPING:

A. Materials: Pressure-sensitive type labels or paint/stencil as specified herein.

B. Sizing of Pipe Markers, Arrows:
   1. Conform to ASME A13.1 as a minimum for legend letter size and length of color field based upon outside diameter of pipe or covering if applicable.
   2. Size of arrows shall be coordinated with pipe marker and letter size and be based upon outside diameter of pipe or covering if applicable.

C. Color Coding:
   1. Jet A piping systems:
      a. Label in accordance with EI Std 1542. Label or stencil flow direction on piping.
      b. Provide pressure sensitive type labels, Gammon Technical Products GTP-2135-5 (JET-A) or equal.
   2. Miscellaneous Piping Systems:
      a. Label in accordance with ASME A13.1.
      b. Use paint/stencils and decals as required.

D. Placards shall be provided on all sump separator inlet lines indicating the filter vessel type and mark number, or storage tank number from which the inlet line emanates. Placards shall also indicate the line fill in gallons between the filter vessel or tank and the sump separator inlet valve. Placard construction shall be as follows:
   1. Engraved type break- resistant and weather-resistant fiberglass, 3-ply laminate with contrasting core.
   2. 3/8-inch-high lettering on plate of width and length as required.
   3. Finish and color combination as selected by Engineer from manufacturer's standard.
   4. Provide with mounting holes and brackets suitable for mounting to piping to be labeled.

2.03 IDENTIFICATION OF FUEL EQUIPMENT:

A. Materials: Protective Coatings as specified in Section 33 52 46.

B. General: Stencil equipment designation with black paint on tanks, filters, sump separators, and pumps. Marking scheme and arrangement shall be submitted for approval by Engineer.

C. All fuel system valves shall be painted black.

D. Nomenclature: Follow equipment designations used on mechanical flow diagram, arrangement drawings, and control room graphics panel.
   1. Filter change dates shall be stenciled on filtration vessels.

2. Fuel storage tank identification shall include tank designator, nominal shell capacity, and fluid type.
3. Main fuel storage tanks shall have dates and descriptions stenciled or labeled for "CLEANED AND PLACED IN SERVICE ON…." and "TANK COATING APPLICATION COMPLETED ON…."
4. Provide hazard identification markers (diamonds) for new storage tanks and existing tanks where existing markers are disturbed during construction. Markers shall be in accordance with NFPA 704. Provide ratings as follows:
   a. Jet A: Blue (Health) 0, Red (Fire) 2, Yellow (Reactivity) 0, and White (Special) is Blank

E. Sizes:
1. Pumps - minimum 4-inch high letters.
2. Filters vessels, sump separators - minimum 6-inch high letters, 2 places each (labels shall be spaced 180-degrees from each other).
3. Storage tanks - minimum 12-inch high letters, 4 places each (labels shall be spaced 90-degrees from each other).

2.04 VALVE IDENTIFICATION TAGS:

A. Provide identification tags for all valves as described below. Permanently install in easily visible locations.
B. Valve Tags:
1. Tags shall be 1 3/8-inch-diameter brass or stainless steel with 1/4-inch high depressed black filled letters attached with brass or stainless steel S-hooks and chains if required. Bead chain is not allowed.
2. Use Engineer-approved numbering system with complete list and description of each number.
3. Provide valve tags for all valves, including Owner-furnished valves.
4. All ball valves on high point vents and low point drains shall be labeled accordingly (HPV or LPD) along with numbering system as approved by Engineer.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances which would affect adhesion.
B. On painted surface, install label only after coating system is complete and dry.

3.02 LOCATIONS:

A. Piping Labels:
1. Use proper label type suitable for interior or exterior location as applicable.
2. Locate labels on piping near connections to equipment, adjacent to valves or fittings, and at intervals not to exceed 25 feet.
3. For piping with arrows, indicate direction of flow. Place arrows adjacent to or below labels, depending upon visibility. For dual-flow piping, indicate both directions.
4. Locate labels to be visible from normal line of vision above floor finish or grade level.
5. Replace labels which do not adhere properly.

B. Equipment Identification:
1. Identification should be visible from normal operating position, platform, and control room.

2. Location of identification shall be approved by Owner.

END OF SECTION 33 52 44

SECTION 33 52 45 – FUEL SYSTEM PIPE, CONNECTIONS, AND INSTALLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers aircraft fueling system piping, fittings, welded and screwed connections, welding procedures, materials, radiographic (and other nondestructive examination) requirements, and construction requirements.

B. Aboveground and belowground piping shall be of conventional single-wall construction with pipe and fittings as specified herein for "Fuel Pipe".

C. Unless otherwise specified, all items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with maximum operating condition of 275 psig, within a temperature range of -20ºF to 100ºF, and having a specific gravity of 0.81 ±0.05.

D. All end connections on piping and fittings to be welded shall be prepared for butt welding, without backing ring. Butt welding end preparation shall conform to ASME B16.25.

1.03 RELATED REQUIREMENTS:

A. Section 31 20 01 - Site Preparation and Earthwork.
B. Section 33 52 43 - Fuel System General Requirements.
C. Section 33 52 44 - Identification of Fuel Piping and Equipment.
D. Section 33 52 46 - Fuel System Coatings for Corrosion Protection.
E. Section 33 52 47 - Fuel System Valves.
F. Section 33 52 48 - Fuel System Accessories.
G. Section 33 52 50 - Fuel System Pumps.
H. Section 33 52 51 - Fuel System Filtration.
I. Section 33 52 53 - Inspection, Testing, and Flushing.
J. Section 33 56 41 - Shop Fabricated Aboveground Storage Tanks.
K. Section 33 56 43 - Fuel System Aboveground Storage Tanks (Field Fabricated).
L. Section 33 56 45 - Aboveground Oil Water Separator

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

B. American Petroleum Institute (API):
   1. Spec 5L - Line Pipe.
   2. Spec 6FB - Fire Test for End Connections.

C. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.
   2. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   3. B16.11 - Forged Fittings, Socket-Welding and Threaded.
   4. B16.20 - Metallic Gaskets for Pipe Flanges.
   5. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
   6. B16.25 - Buttwelding Ends.
   7. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60.
   8. B31.3 - Process Piping.
   9. BPVC Section V - Nondestructive Examination.

10. BPVC Section IX – Welding, Brazing, and Fusing Qualifications.

D. American Society for Testing and Materials (ASTM):
   1. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   2. A105 - Carbon Steel Forgings for Piping Applications.
   3. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
   4. A139 - Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
   5. A182 - Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   6. A193 - Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   7. A194 - Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   8. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperatures Service.
   9. A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   10. A312 - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   11. A403 - Wrought Austenitic Stainless Steel Piping Fittings.
   12. D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

E. Manufacturers Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.

1.05 SUBMITTALS:

A. Submit as specified in Section 33 52 43.

B. Include, but not limited to, the following:
   1. Mill Test Reports.
   2. Fuel Piping Materials.
   3. Fittings for Welded Fuel Pipe.
   4. Fittings for Threaded Fuel Pipe.
   5. Stainless Steel Pipe and Fittings.
   6. Carbon Steel Flanges.
   7. Stainless Steel Flanges.
   8. Flange Gaskets.
   9. Flange Bolts and Nuts.
   10. Isolating Flange Kits.
   11. Pipe Supports.
   12. Welding Filler Materials.
   13. Threaded Pipe Joint Sealants.
   14. Instrument Tubing, Fittings, and Tray.
   15. Pipe Sleeves.
   16. Pipe Sleeve Seals (Segmented Modular Seals).
   17. Testing Laboratory (RT).
   18. Radiographic Examination Reports.
   19. Testing Laboratory (MT and PT).
   20. Magnetic Particle and Liquid Penetrant Examination Reports.

1.06 QUALITY ASSURANCE:

A. All pipe and piping materials shall be produced by a manufacturer acceptable to Owner.

B. Unless otherwise specified, low melting point and brittle materials (e.g. aluminum and cast iron) shall not be provided in fuel Equipment and Materials.
C. Mill Test Reports: Subcontractor shall submit the mill test reports (MTRs) for all pipe and fittings before or upon delivery to the project site.
D. All supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products from one of the listed manufacturers.
   1. Flange Gaskets:
      a. Flexitallic.
      b. Garlock.
      c. Klinger.
      d. Lamons.
      e. Approved equal.
   2. Isolating Flange Kits:
      a. Advance Products & Systems.
      b. GPT (EnPro Industries).
      c. Approved equal.
   3. Pipe Supports:
      a. E-Z Line Pipe Support Co.
      b. Anvil International.
      c. Cooper B-Line.
      d. Piping Technology & Products.
      e. Approved equal.
   4. Instrument Tubing, Fittings, and Tray:
      a. Hoke.
      b. James C. White Company.
      c. Parker.
      d. Sandvik.
      e. Swagelok.
      f. Approved equal.
   5. Pipe Sleeve Seals (Segmented Modular Seals):
      a. Advance Products & Systems.
      b. GPT (EnPro Industries).
      c. Approved equal.

2.02 FUEL PIPING MATERIALS:

A. Pipe shall be ASTM A53 Grade B, ASTM A106 Grade B, or API Spec 5L Grade B, seamless or electric resistance welded, double random lengths to reduce the number of joints. Stamp all pipe and stencil/label coated pipe with specification and grade. Double submerged arc welded pipe (DSAW) is not acceptable.

B. Pipe 2 inches and smaller shall be seamless, Schedule 80. Pipe 2 1/2 inches through 10 inches shall be Schedule 40 (Standard Weight). Pipe 12 inches or larger shall be Standard Weight (0.375-inch wall thickness).

C. All buried piping shall have full penetration welded connections. Socket-weld connections shall be used for pipe 2 inches and smaller in pits and aboveground piping except for connections to threaded valves, and other equipment. Buried socket-weld connections shall only be provided where indicated on the Drawings. Perform non-destructive examination of all buried socket-welds in accordance with the "Magnetic Particle and Liquid Penetrant Examination" Article of this Section. Threaded and flanged connections are prohibited on all buried piping.

D. Pipe or fittings in the fuel piping systems shall not be galvanized, zinc-plated, brass, bronze, or other brittle or low melting point material.

E. Mill Cleaning and Coating of Pipe:
   1. All fuel pipe 2 1/2 inches and larger and fittings 6 inches and larger shall be internally epoxy lined at the mill, as specified in Section 33 52 46. Provide internal pipe coating (System E-4) for all fuel piping and external pipe coatings for all buried piping (Systems E-5, E-12, and E-12A).
   2. All fuel pipe and fittings shall be externally coated as specified in Section 33 52 46.
   3. Clean inside and outside of pipe and fittings by sand or grit blasting, or pickling to remove all mill scale.
   4. Apply in the mill an approved rust preventive coating to the interior and exterior of pipe and fittings immediately after cleaning. Rust preventive shall be approved by Owner and applied as recommended by the manufacturer. Rust preventive coating may be deleted from the pipe interior if pipe is internally epoxy lined immediately after cleaning. Rust preventive coating may be deleted from the pipe exterior if the pipe is externally epoxy coated immediately after cleaning.
   5. The ends of the pipe shall be capped at the factory using suitable galvanized metal or plastic caps, secured with a double wrap of 2-inch wide pressure sensitive tape.

2.03 FITTINGS FOR WELDED FUEL PIPE:

A. Butt welding type carbon steel, ASTM A234 Grade WPB, ASME B16.9 for buried fuel piping. Wall thicknesses shall match pipe.

B. Socket-weld type forged steel, ASTM A105, conforming to ASME B16.11 Class 3000, for sizes 2 inches and smaller. Butt weld fittings conforming to ASME B16.9 in lieu of socket weld are acceptable for sizes 2 inches and smaller.

C. Elbows shall be long radius unless noted otherwise.

D. Changes in direction of pipe of other than 45 degrees or 90 degrees shall be made as follows:
   1. With segmental long radius weldells, factory-made to the proper angle and shop beveled.
   2. Or, at the option of Subcontractor, with pipe bends in accordance with ASME B31.3. Pipe roundness shall be maintained to factory tolerance for straight pipe lengths. Submit shop drawings of all bends and bending procedures for approval by Engineer.
   3. Bends of 2 degrees or less may be mitered joints.

E. Welded Branch Connections:
   1. Welded branch connections shall be butt welding tees except as described herein and with Engineer's approval.
   2. Fabricated tees shall be insert-type weldolets, elbolets, or vessolets. Standard weldolets shall be allowed only where indicated on the Drawings for below ground connection to existing hydrant lines. Fittings and connections shall provide a smooth and accessible surface suitable for 100 percent radiographic examination of all welds.

3. Standard weldolets may be used for welded branch connections for aboveground piping.
4. Fabricated branch connections for aboveground piping 2 inches and smaller shall be sockolets or elbolets. Threadolets shall only be used where indicated on the drawings. Field-fabricated half couplings shall not be used.

2.04 FITTINGS FOR THREADED FUEL PIPE:

A. Forged steel, ASTM A105, conforming to ASME B16.11 Class 3000.
B. Threads of threaded jointed piping shall be full, clean, sharp, and true.
C. Bushings shall not be used except as noted on the Drawings.
D. Threaded fittings shall only be used where indicated on the drawings.

2.05 STAINLESS STEEL PIPE AND FITTINGS:

A. Pipe shall be stainless steel ASTM 312,Type 304, or dual certified 304/304L, seamless Schedule 40s.
B. Fittings 2 1/2 inches and larger shall be butt welded, stainless steel ASTM A403 Type 304, or dual certified 304/304L, conforming to ASME B16.9. Fittings shall be of the same thickness as the adjoining pipe.
C. Fittings 2 inches and smaller shall be socket-weld, forged stainless steel ASTM A182 Type F304, or dual certified F304/304L, conforming to ASME B16.11 Class 3000. Butt welded fittings conforming to ASME B16.9, in lieu of socket-weld, are acceptable for sizes 2 inches and smaller.
D. All bolted connections (flanges) in stainless steel piping and between stainless steel and carbon steel piping shall have stainless steel bolting as specified below.

2.06 CARBON STEEL FLANGES:

A. Standard weldneck type forged steel, ASTM A105, conforming to ASME B16.5 Class 150, except where Class 300 flanges are required to correspond to the equipment to which the piping is joined, or as indicated on the Drawings. Inside diameter of flanges shall be bored to match the inside diameter of the adjoining piping.
B. For piping 2 inches and smaller, weldneck type or socket-weld type forged steel, ASTM A105, conforming to ASME B16.5 Class 150, except where Class 300 are required to correspond to the equipment to which the piping is joined, or as indicated on the Drawings.
C. Flange facings shall correspond to the equipment to which the piping is joined, and unless otherwise required, shall be standard 1/16-inch raised face. Raised face flanges shall not be used to join to flat faced equipment or nozzles.
D. Slip-on type flanges of the Class specified shall only be provided where indicated on the Drawings. Slip-on flanges shall be double-welded unless otherwise approved by the Engineer.

2.07 STAINLESS STEEL FLANGES:

A. Standard weldneck type forged stainless steel, ASTM A182 Type F304, or dual certified Type F304/304L, conforming to ASME B16.5 Class 150, except where Class 300 flanges are required to correspond to the equipment to which the piping is joined, or as indicated on the Drawings. Inside diameter of flanges shall be bored to match the inside diameter of the adjoining piping.
B. For piping 2 inches and smaller, weldneck type or socket-weld type are allowable.
C. Flange facings shall correspond to the equipment to which the piping is joined, and unless otherwise required, shall be standard 1/16-inch raised face. Raised face flanges shall not be used to join to flat faced equipment or nozzles.

D. Slip-on type flanges of the Class specified shall only be provided where indicated on the Drawings. Slip-on flanges shall be double-welded unless otherwise approved by the Engineer.

2.08 FLANGE GASKETS:

A. Gaskets shall be resistant to the effects of aviation hydrocarbon fuels and manufactured of fire-resistant materials.
B. Ring gaskets shall be spiral-wound with 304 stainless steel windings, flexible graphite "fire rated" filler or approved equal, and inner rings to prevent inward buckling of the stainless steel windings. Ring gaskets shall conform to ASME B16.20. Spiral-wound gaskets shall be 0.175 inches in uncompressed thickness.
C. Full face gaskets shall be 1/8-inch thickness and be of fire-resistant composite material. Full face gaskets shall conform to ASME B16.21.
D. Ring gaskets shall be used for steel flanged joints with raised face flanges.
E. Full face gaskets shall be used for steel flanged joints with flat face flanges and manways.
F. Class and pressure rating of gaskets shall match the flanges to which the gasket is installed.

2.09 FLANGE BOLTS AND NUTS:

A. Carbon Steel:
   1. Machine bolts shall be heavy hexagonal alloy carbon steel conforming to ASTM A193 Grade B7.
   2. Nuts shall be heavy hexagon alloy carbon steel conforming to ASTM A194 Grade 2H.
B. Stainless Steel:
   1. Machine bolts shall be heavy hexagonal alloy austenitic steel conforming to ASTM A193 Grade B8, Class 2.
   2. Nuts shall be heavy hexagon alloy austenitic steel conforming to ASTM A194 Grade 8.
C. Stud bolts may be used as required for corresponding equipment. Stud bolts shall be factory fabricated and not cut from all-thread rod.

2.10 ISOLATING FLANGE KITS:

A. Joints shall consist of weldneck companion flanges or a weldneck flange with mating valve flange, and an isolating flange kit.
B. Isolating gaskets shall be full-face, flat G-10 glass-reinforced epoxy core with Viton sealing element. Gasket thickness shall be nominal 1/8-inch thick for ASME B16.5, Class 150 raised face flanges. Minimum dielectric strength shall be 800 VPM conforming to ASTM D149.
C. Isolating washers shall be G-10. Dielectric strength shall be compatible with minimum insulating values of isolating sleeves and gaskets. Furnish double quantity of isolating G-10 and zinc-plated steel washers for "full" isolation of flanges.
D. Isolating sleeves shall be G-10, length as required to match thickness of two Class 150 raised face flanges plus isolating gasket. Sleeves shall provide "full" insulation of bolts; minimum dielectric strength shall be 800 VPM.
E. Provide isolating (insulating) joints at the locations indicated.
F. Isolating flange assemblies shall provide a minimum resistance of 1,000 ohms measured between each bolt and both flanges (when dry).

2.11 PIPE SUPPORTS:

A. Support design and location shall be as indicated on Drawings. Refer to Section 33 52 43.
B. Provide complete assemblies adequately rated for the applied loads.
C. Provide all required inserts and anchors prior to concrete placement.
D. Where indicated on the Drawings, expansion bolts shall be Hilti or approved equal.

E. Spacing and arrangements shall conform to ASME B31.3.
F. Support locations are indicated on the Drawings for pipe sizes 2 1/2 inches and larger only, based on the pipe routing shown. Subcontractor shall locate and provide supports for piping smaller than 2 1/2 inches in accordance with ASME B31.3 and MSS SP-58.
G. Subcontractor shall provide additional supports as required due to changes in the pipe routing or equipment supplied.
H. Reduce spacing by one quarter where changes in direction occur.
I. Pipes running parallel in the same plane may be supported on gang supports.
J. Install to prevent sag or vibration and to adequately support the piping without interfering with inherent flexibility. The maximum allowable pipe sag is 1/8 inches.
K. Make adjustments after systems are placed in operation.
L. Explosion or powder driven fasteners shall not be used.

2.12 WELDING FILLER MATERIALS:
A. Welding filler material shall be provided in accordance with the applicable Welding Procedure Specification.
B. Filler materials shall be compatible with the base metal and shall be specified and purchased by ASME BPVC Section IX or AWS classification and chemical composition.
C. Welding electrodes and filler materials shall be properly stored in suitable regulated temperature enclosures in accordance with manufacturer's recommendations. The use of wet or moist electrodes will not be permitted.

2.13 THREADED PIPE JOINT SEALANTS:
A. Either of the two materials specified below may be used for sealing of threaded carbon steel pipe joints unless otherwise specified. All threaded joints shall be sealed.
B. Screwed Pipe Joint Tape: PTFE tape applied to male threads. Tape width, number of wraps, and use of additional paste sealant shall be in accordance with tape manufacturer's recommendations.
C. Screwed Pipe Joint Compound: Use compound which is resistant to the effects of aviation hydrocarbon fuels and Underwriters' Laboratories approved for the application intended.
D. For stainless steel threaded joints, provide nickel impregnated PTFE pipe joint tape. Tape width, number of wraps, an use of additional paste sealant shall be in accordance with tape manufacturer’s recommendations.

2.14 INSTRUMENT TUBING, FITTINGS, AND TRAY:
A. Tubing:
1. Material shall be ASTM A269 Type TP316 annealed, seamless stainless steel.
2. Wall thickness shall be as required by the fittings, but not less than 0.049 inches.
B. Fittings:
1. Stainless steel compression type tube fittings for flareless tubes. Fitting connections shall be of four-piece construction including nut, front and back (double) ferrules, and fitting body.
C. Instrument Tray:
1. Tubing shall be installed and routed in a T-304 or T-316 stainless steel instrument tray.
2. Tray shall have a perforated bottom and of a depth to fully enclose the instrument tubing.
3. Changes in direction shall be with manufactured fittings of same size and material as the tray.
4. Support instrument tubing within the tray at intervals not to exceed 5 feet, or as required to prevent vibration.

a. Supports hardware shall be stainless steel.
b. Tubing clamps shall be UV and oil resistant nylon.

2.15 PIPE SLEEVES:

A. Provide sleeves for all pipes passing through equipment pads, slabs, valve vault walls, and other concrete or masonry structures.
B. Sleeve sizes through 10 inches shall be Schedule 40 carbon steel pipe.
C. Provide a 2-inch wide anchor collar of the same type of steel as the sleeve pipe. The collar shall be welded all around and on both sides to the sleeve pipe. The collar shall be positioned on the sleeve pipe such that the collar is located at the mid-point in the structural wall or pad when the sleeve is in place.
D. Sleeves shall be hot-dipped galvanized after fabrication.
E. Sleeves shall be 2 inches larger in nominal pipe size for pipes less than 4-inch nominal diameter and two pipe sizes larger for pipes 4-inch nominal diameter and larger. Coordinate sleeve dimension with sleeve seal specified herein.
F. Sleeves through walls shall be cast in place, unless otherwise indicated on the drawings. Sleeves through pads shall be cast in place. Piping shall be installed centered in sleeve.

2.16 PIPE SLEEVE SEALS (SEGMENTED MODULAR SEALS):

A. Segmented modular mechanical seals consisting of interlocking elastomer links.
B. Elastomer links shall be oil resistant nitrile with reinforced nylon polymer pressure plates and 316 stainless steel hardware.
C. Size shall be as determined by the manufacturer for the application.
D. Use one seal at each end of the sleeve through walls to keep the pipe in proper alignment.
E. Arrange seal hardware to be accessible from grade after completion of the Work.

PART 3 - EXECUTION

3.01 HAULING AND STRINGING PIPE:

A. Perform the hauling and stringing of pipe and other materials in such a manner as to prevent damage to pipe and material. If damage is sustained, Subcontractor shall be responsible for repair or replacement cost.
B. Galvanized metal or plastic caps covering the ends of the pipe shall remain in place until the welding of the pipe. If any caps are not in place, resecure to the pipe ends to prevent dirt, water, and other foreign material from entering the pipe.
C. String pipe on right-of-way in such a manner as to cause the least interference with the normal use of the land crossed. Leave gaps at intervals to permit use of land and passage of equipment.
D. Subcontractor shall promptly repair, at their own expense, all roads, fences, building, or other property damaged by them in the progress of the Work.

3.02 LAYING UNDERGROUND PIPE:

A. Lay, embed, and maintain all underground pipelines to the flow-line elevation and grades shown on the Drawings. Pipelines shall continuously slope between the high point vents and the low point drains without intermediate high points or low points.
B. The full length of each section of pipe shall rest solidly upon the pipe bed of compacted sand at depth as indicated. Sand bags or blocking shall be removed prior to final pipe bedding backfill.
C. Any pipe that has the grade or joint disturbed after being laid shall be taken up and re-laid.
D. Do not lay pipe in water or when trench conditions are unsuitable, except by written permission of Owner.

E. Anchor pipe during installation to prevent floatation prior to placement in service.
F. Install pipe to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other utilities or structures.
G. Where coated fuel pipes cross other pipes, conduits, cables, or metallic structures with a separation of less than 6 inches, provide an insulating separator.
H. Insulating separators shall be minimum 36-inch by 36-inch by 1/2-inch thick UHMW polyethylene sheets or of a size that will span/overlap the crossing by 1 foot in each direction.

3.03 INSTALLATION OF ABOVEGROUND PIPE:

A. Install complete with valves, fittings, and accessories and make all necessary connections.
B. Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements.
C. All fabrication and installation shall conform to ASME B31.3.
D. Verify all measurements, and location of existing facilities and underground piping, before commencing Work. Submit discrepancies for clarification before proceeding with the installations.
E. Arrange all piping with proper slopes, true to line, without sags, traps, or pockets, and pitched to drain at the lowest points so that entire systems can be emptied.
F. Provide high point vents, pump outs, and low point drains as required or indicated on the Drawings.
G. Provide companion flanges, where indicated, and as required elsewhere to permit satisfactory disassembly of small bore piping for threaded equipment maintenance.

3.04 HANDLING COATED PIPE:

A. Storage Racks:
   1. Storage rack material shall be 4 to 6 inches in bearing width and placed not less than 10 feet apart.
   2. Do not rack pipe 10 inches in diameter and larger more than two sections in height, and pipe 8 inches and under not more than four sections in height.
   3. Protect all racked pipe by use of suitable padded material between sections.
   4. All coated pipes shall be protected from ultraviolet deterioration.
B. Handling Operation:
   1. All trucks handling coated pipe shall have properly padded bolsters, chains, and binders so as to not damage the coating.
   2. Pipe shall not be rolled off the truck but shall be carefully lowered onto the skids by mechanical equipment.
   3. Coated and wrapped sections of pipe must be lifted with slings of approved width and are not to be dragged or pulled into position.

3.05 PIPE CLEANING:

A. Clean each pipe joint before welding into the system, to remove all deleterious material.
B. Remove materials such as water, dirt, welding rods, construction debris, trash, and similar materials, left inside after completion of the lines.

3.06 GAS FREE CONDITIONS:

A. All operations in the construction area that involve open flames, or the possibility of arcing or sparking shall be conducted in a "Gas Free" condition.
B. These operations shall include, but not be limited to the following:

1. Use of internal combustion engines not equipped with Underwriters' approved spark and flame eliminators.
2. Use of electric motors or electric devices with arcing brushes or sliding contacts that could produce arcing or sparking.
3. Use of tools which may produce impact sparks.
4. Electric or gas welding.
5. Use of cutting or other torches, or other open flame equipment.
6. Holiday testing.
7. Use of equipment with hot surfaces or glowing elements.
8. Use of any other equipment or procedure that could create a fire hazard.

C. Monitor the use and suitability of the equipment and procedures on the job and maintain a safe "Gas Free" condition when necessary, during construction.

D. Prior to commencing any phase of the Work requiring a gas free condition, the following provisions shall be provided:
1. Empty pipes containing fuel and purge of all vapors.
2. Isolate, blank off, and adequately ventilate open piping sections so that no part of the pipe containing fuel or vapors is exposed.
3. Drain and ventilate fuel tanks prior to work inside tanks or on any of the tank connections.
4. Make certain that there are no open pools or reservoirs of fuel exposed in the vicinity of the Work.
5. Perform all other safety precautions necessary to ensure that these operations are conducted in a safe manner in accordance with all applicable codes.

E. Use a combustible gas analyzer to make certain no combustible gas concentrations exist in the construction area when performing these operations.

3.07 PERMITS:

A. Provide special permits required for any work under the various Subsections of this Section of the Specifications and pay all permit fees.

3.08 WELDED JOINTS:

A. Welding shall be accomplished by the use of the shielded metallic arc process, with the exception of tie-in welds that may use the gas tungsten-arc welding (GTAW/TIG) process to complete root passes, and shall be in strict accordance with ASME B31.3 and the submitted Welding Procedure Specifications for the Project.

B. Upon award of the Contract, submit for review the welding procedures and qualifications that are intended to be used on the Project, in accordance with Section 33 52 43.
1. Owner reserves the right to request qualification tests be performed at the Job Site for each welder and welding operator on the job, such tests being made in strict compliance with the above code.

C. Shop welding and fabrication shall be subject to the right of Owner to maintain one or more inspectors in the shop or to visit the shop at any time this Work is in progress.

D. Identification:
1. Each welder shall identify his welds with specific code markings signifying his name and assigned number.
2. Subcontractor shall maintain a code listing assigned to each welder.
3. Stamp on the pipe using "low stress" steel stamp, or other approved method, not closer than 4 inches to a weld.

E. Butt Welding End Preparation on all Pipe:

1. Conform to ASME B16.25.
2. Shop and field bevels shall be machine cut; manual flame cutting without machine guide shall not be permitted.

F. All welds shall have full penetration and fusion and shall conform to ASME B31.3.
G. Backing rings shall not be used.
H. Prior to welding, remove factory or field applied internal and external coatings at the girth weld by grinding or wire brush. Remove 1 to 1 1/2 inches from each end.
I. Align pipe joints with pipe clamps prior to welding. Clamps or other alignment devices shall not reduce the internal pipe diameter.
J. Defective welds shall be repaired in accordance with ASME B31.
K. Repairs to defective welds shall not be made prior to authorization. Owner will determine on the basis of the testing laboratory report if repairs may be made or if the entire joint must be cut out and welded again.
L. No weld metal shall project within the piping at completion of the welding.

3.09 RADIOGRAPHIC EXAMINATION (RT):

A. Coordinate and provide radiographic examination, by the approved testing laboratory.
B. All (100 percent) of welds shall receive radiographic examination for all underground fuel pipe and inaccessible fuel lines, except for welds specified to be examined in accordance with the "Magnetic Particle and Liquid Penetrant Examination" Article of this Section.
C. No less than 10 percent of selected aboveground welded joints shall receive radiographic examination. The progressive sampling for examination criteria of ASME B31.3, Section 341.3.4 will apply.
D. Radiographic examination shall apply to circumferential butt welds and fabricated branch connections.
E. The testing laboratory's (RT) qualifications shall be submitted and will be subject to Owner's approval.
F. Factory welds of the final fuel pipe shall be examined by the approved testing laboratory. Radiographic examination of factory welds may be conducted at the factory site.
G. Radiographic Examination Reports:
    1. Reports for both factory and field welds shall be submitted throughout the progress of the Work as described below.
    2. All examination, acceptance criteria, and subsequent reports shall be in accordance with the requirements of ASME B31.3.
    3. Each weld shall be assigned a number. Subcontractor shall maintain a marked up copy of piping drawings identifying the location and number of each radiographed weld. Upon completion of the Work, these drawings shall be submitted with as-constructed drawings.
    4. Radiograph film or digital exposure records shall be kept by the testing laboratory which show date, location, area, film number, serial number, film combination, time, source-film distance, angulation, weld number and other pertinent information for each weld examined.
    5. A summary of this record and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Engineer, and Contractor.
H. All joints shall be left exposed until radiographic and other examinations are completed.
I. Acceptance criteria shall be in accordance with ASME B31.3, Table 341.3.2, Normal Fluid Service.
J. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3 sections, will be judged unacceptable and shall be repaired or cut out and

rewelded as directed by the testing laboratory. Repaired welds shall again receive radiographic examination.

K. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.

3.10 MAGNETIC PARTICLE (MT) AND LIQUID PENETRANT (PT) EXAMINATION:

A. Coordinate and provide magnetic particle and liquid penetrant examination by the approved testing laboratory.

B. All (100 percent) of welds shall receive magnetic particle and liquid penetrant examination for new buried socket-weld connections.

C. No less than 10 percent of selected aboveground socket-weld and fillet weld connections shall receive magnetic particle and liquid penetrant examination. The progressive sampling for examination criteria of ASME B31.3, Section 341.3.4 will apply.

D. The magnetic particle and liquid penetrant examinations shall be conducted on the entire 360-degree circumference of each socket-weld and weldolet.

E. The testing laboratory's (PT and MT) qualifications shall be submitted and will be subject to Contractor's approval.

F. Magnetic Particle and Liquid Penetrant Examination Reports:

1. Reports for field welds shall be submitted throughout the progress of the Work as described below.
2. All magnetic particle and liquid penetrant examinations and subsequent reports will be in accordance with the requirements of ASME B31.3 and ASME BPVC Section V.
3. Each weld shall be assigned a number. Maintain a marked up copy of piping drawings identifying the location and number of each weld. Upon completion of the Work, these drawings shall be submitted with as-constructed drawings.
4. Magnetic particle and liquid penetrant examination records shall be kept by the testing laboratory and shall show date, location, area, weld number, and other pertinent information for each weld tested.
5. A summary of this record, and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Engineer, and Contractor.

G. All fittings shall be left exposed until examination is completed.

H. Acceptance criteria shall be in accordance with ASME B31.3, Paragraph 344.3.2 for magnetic particle examination, and ASME B31.3, Paragraph 344.4.2 for liquid penetrant examination.

I. Welds which do not meet the standards of acceptability as outlined in the above mentioned ASME B31.3 section will be judged unacceptable and shall be repaired or cut out and rewelded as directed by the testing laboratory. Repaired and rewelded joints will then be retested.

J. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.

END OF SECTION 33 52 45

SECTION 33 52 46 – FUEL SYSTEM COATINGS FOR CORROSION PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers the field- and shop-applied corrosion protection coatings of exterior and interior surfaces for fuel system piping, pipe supports, valves, fittings, aboveground tanks, Equipment, structural steel, and all Materials to be located underground. Coating systems are specified by "Protective Coating System" sheets at the end of this Section.

B. Coating includes surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and Equipment. Shop preparation, prime coat and finish coats to be shop applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop applied such as for structural steel, or Equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
3. Where Equipment or Materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
4. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop applied.

C. See Specification Section 33 52 45 for special safety requirements for a "gas-free" condition during certain operations in the construction area.

D. Colors:

1. Colors shall be selected after submittal of approved manufacturer's color Samples.
2. Color of finish coatings shall match accepted color Samples.
3. When second and finish (third and fourth) coats are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat.

E. Provide internal pipe coating (System E-4) for all fuel piping and external pipe coatings for all buried piping (Systems E-5, E-12, E-12A).

1.03 RELATED REQUIREMENTS:

A. Section 21 39 39 - Low Expansion Foam Systems
B. Section 33 52 43 - Fuel System General Requirements.
C. Section 33 52 44 - Identification of Fuel Piping and Equipment.
D. Section 33 52 45 - Fuel System Pipe, Connections, and Installation.
E. Section 33 52 47 - Fuel System Valves.
F. Section 33 52 48 - Fuel System Accessories.
G. Section 33 52 50 - Fuel System Pumps.
H. Section 33 52 51 - Fuel System Filtration.
I. Section 33 52 53 - Inspection, Testing, and Flushing.
J. Section 33 56 43 - Fuel System Aboveground Storage Tanks.
K. Section 33 56 45 - Aboveground Oil Water Separator.

1.04 REFERENCE STANDARDS:

A. Association for Materials Protection and Performance (AMMP, formerly the Society for Protective Coatings (SPCC)):
   1. SP 1 - Solvent Cleaning. Removes oil, grease, soil, and other substances. Used with other methods to remove rust, paint, and mill scale.
   2. SP 3 - Power Tool Cleaning. Removes loose material. Not intended to remove all scale or rust.
   3. SP 5 - White Metal Blast Cleaning. Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
   4. SP 6 - Commercial Blast Cleaning. Two-thirds of every 9 square inches free of all visible residues; remainder only light discoloration.
   5. SP 7 - Brush-Off Blast Cleaning. Removes only loose material, remaining surface tight and abraded to give anchor pattern.
   6. SP 10 - Near-White Blast Cleaning. At least 95% of every 9 square inches shall be free of all visible residues.
   7. SP 11 - Power Tool Cleaning to Bare Metal.
   8. SP 16 – Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-ferrous metals.
   9. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
   10. QP 3 - Certification Standard for Shop Application of Complex Protective Coating Systems.

B. American Water Works Association (AWWA):
   1. C213 - Fusion-Bonded Epoxy Coating for The Interior and Exterior of Steel Water Pipelines.

C. Energy Institute (EI):
   1. 1541 - Requirements for internal protective coating systems used in aviation fuel handling systems.

1.05 SUBMITTALS:

A. Submit as specified in Section 33 52 43.

B. Includes, but not limited to, the following:
   1. Schedule of products to be used. Schedule shall include the following information:
      a. Surfaces for system to be applied.
      b. Surface preparation method and degree of cleanliness.
      c. Product manufacturer, name, and number.
      d. Method of application.
      e. Dry film mil thickness per coat of coating to be applied.
   2. Color charts for selection and acceptance.

C. Technical and material safety data sheets.

D. Documentation the tank interior lining systems meets EI 1541 testing requirements.

E. Field Applicator SSPC-QP 1 certification.

F. Shop Applicator SSPC-QP 3 certification.

1.06 QUALITY ASSURANCE:

A. Include on label of container:
   1. Manufacturer's name, product name, and number.
   2. Type of paint and generic name.

3. Color name and number.
4. Storage and temperature limits.
5. Mixing and application instructions, including requirements for precautions which must be taken.
6. Drying or curing time.

B. Qualifications:
1. Provide SSPC-QP 1 certification for field applied coatings and SSPC-QP 3 certification for shop applied coatings, as applicable.
2. In lieu of above certifications, provide recent project experience by the Project's coating applicators for review by Engineer.

C. Factory-Applied Pipe Coatings:
1. Certification of quality control procedures during application of internal and external coatings shall be submitted to Engineer for review. Certification to include: Surface preparation, film thickness per coat, curing procedures, and holiday testing.

D. Certified Coating Inspector:
1. Submit documentation that coating inspector is an employed NACE Level III Certified Inspector, qualified to adequately inspect all surface preparations and protective coating applications included in the Work.
2. The inspector shall be present during all field coating work including pre-preparation testing, surface preparation, coating application, initial cure of the coating system, and during all coating repair.
3. The inspector shall provide complete documentation of conditions and occurrences on the job site and in the tank plate coating shop, and be aware of conditions and occurrences that are potentially detrimental to the coating system.

E. In the event a problem occurs with coating system, surface preparation, or application, coating manufacturer's technical representative shall promptly investigate the problem and submit results to Engineer.

F. Stated VOC shall be unthinned maximum VOC certified by manufacturer. Maximum VOC allowable in this area shall be verified and complied with.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Delivery of Materials:
1. Deliver in sealed containers with labels and information legible and intact.
2. Allow sufficient time for testing if required.

B. Storage of Materials:
1. Store only acceptable materials on Project Site.
2. Provide separate area and suitable containers for storage of coatings and related equipment.
3. Dispose of used or leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Proprietary names and product numbers are specified in most protective coating system data sheets for material identification.

B. Subject to compliance with specified requirements, provide products from the listed manufacturers.

1. Axalta Coating Systems (Dupont).
2. Carboline Company, Inc.
3. Sherwin-Williams.
4. International.
5. Tnemec Company, Inc.
6. Valspar.
7. Devoe - AkzoNobel.
8. Polyken Pipeline Coatings.
9. Tapecoat Company.
10. Denso North America.
11. 3M Electrical Specialties Division.
12. PPG.
13. Futura.

2.02 GENERAL:

A. Materials furnished for each protective coating system shall be compatible to the substrate.
B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions or product.
D. Internal pipe coating shall be certified by the manufacturer to be suitable for exposure to Jet A fuel.

2.03 COATING SYSTEMS:

A. Specified on the "Protective Coating System" sheets at the end of this Section. Systems E-4 and E-5 shall be factory-applied.

2.04 SURFACES AND MATERIALS TO BE COATED:

A. System E-4 (provided by mechanical subcontractor):
   1. Internal coating of fuel pipe 2-1/2 inches and larger and fittings 6 inches and larger.
B. System E-5 (provided by mechanical subcontractor):
   1. Exterior of buried fuel piping.
C. System E-12A/E-12 (provided by mechanical subcontractor):
   1. Coating system E-12A shall be used for underground fittings, field welds, and other large repairs to the exterior of buried piping systems. Subcontractor shall confirm with coating manufacturer(s) that planned coatings to be used for System E-5 and System E12-A are compatible at the interface between the two coating systems. Subcontractor will follow any coating manufacturer recommendations regarding establishment of satisfactory bonding at the interface between the two coating systems.
   2. Where interfacing with existing coating systems such as extruded polyethylene, asphalt, coal tar wrap or tape wrap, apply system E-12A to bare pipe and wrap interface between new and existing coating with system E-12. Overlap new tape wrap over existing and new coatings a minimum of 6 inches each.
D. System T-1:
   1. Exterior of new steel aboveground storage tanks (field-coated).
   2. Exterior structural and miscellaneous steel not galvanized including:
      a. Columns, beams, platforms, stair supports, stringers, checkered plate treads, railings, kickplates, and pipe supports.

3. Guard posts (exterior).
4. Light poles (exterior).
5. Aboveground exposed piping, valves, filter vessels, meters, strainers, sump separators, and other fuel equipment with corrodible surfaces (exterior). All fuel system valves shall be painted black.
6. Where specifically indicated, galvanized steel pipe (foam piping, etc.) shall be abrasive-blasted for corrosion coating preparation prior to application in accordance with SSPC-SP 16 or as specified by coating manufacturer.

E. System T-2:
1. Interior of steel storage tanks (new tanks).
2. System to be applied to complete interior of steel storage tanks, including tank shell, floor, roof, roof structure, and internal piping and appurtenances.
3. System T-2 shall comply with EI 1541.

F. System T-3:
1. Exterior of new steel aboveground storage tanks with shop-applied first (prime) coat successive coats field-applied.

G. Pump Skids shall be touched up with coating compatible with factory finish, of color approved by Owner.

2.05 CHIME SEAL/TANK BASE PROTECTION SYSTEM:

A. System shall include four parts:
1. Mastic between the tank foundation and tank bottom projection.
2. Non-woven tape coating with an adhesive compound based on petrolatum, polymers, and inert siliceous fillers.
3. Butyl rubber adhesive tape with a polyester fabric backing.
4. High build, high performance acrylic topcoat.

B. Manufacturer:
1. Denso North America.
2. Approved equal.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparations specifications listed.
1. If grease or oils are present, SSPC-SP 1 shall precede any other method specified.
2. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
3. Prepare surfaces of field welds, sears, or other damage, and touch up with coating as specified or recommended by manufacturer.

B. Depth of profile will be as specified for each system, but in no instance shall it exceed one-third of the coating dry film thickness per coat.

C. Prepare only those areas which will receive the first coat of the system on the same day.

3.02 APPLICATION:

A. Apply coatings in accordance with coating manufacturer's recommendations.

B. Use properly designed brushes, rollers, and spray equipment for all applications.

C. Dry film thickness of each system shall meet the minimum specified but not exceed it more than 20% or coating manufacturer's requirements if less.

D. On unprimed surfaces apply first coat of the system the same day as surface preparation.
E. Shop painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted.
F. Chime Seal/Tank Base Protection System:
    1. The tank bottom projection beyond the tank shell shall be properly prepared in accordance with the manufacturer's recommendations along with the concrete foundation to which the system is to be applied.
    2. System shall permit the inspection of the chime plate in accordance with API Std. 653 and without removal of the system to complete inspections.
G. Environmental Conditions:
    1. Atmospheric temperature must be 50ºF or higher during application, unless approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating curing time requirements.
    2. Wind velocities for exterior applications shall be at a minimum and not greater than coating manufacturer's limits.
    3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5º above the dew point.
    4. Provide adequate ventilation equipment in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Safety Data Sheets for the specific coatings being applied.
    5. Provide temporary enclosures and preheat coating material and surfaces to be coated as recommended by coating manufacturer.
H. Protection:
    1. Cover or otherwise protect surfaces not being painted, areas not to be painted, and the work of other trades. Remove protective materials when appropriate.
    2. Provide signs to indicate fresh paint areas.
    3. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
    4. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.
    5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, thinners, and related materials. Dispose of leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.
    6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 CLEANING:

A. Touch up and restore damaged finishes to original condition as required.
B. Remove spilled, dripped, or splattered paint from all surfaces.

3.04 COATING REPAIRS:

A. Repair all damages to pipe coating systems before the piping is holiday tested.
B. This includes all cuts, breaks, voids, bruised or scarred spots, or other damage caused prior to delivery, or resulting from handling or installation of the pipe, or from any cause whatsoever.
C. Included also are damaged coatings where new connections are made to existing coated pipes or where existing coated pipes are uncovered or exposed for any reason.
D. Also repair the coating where welds are made and where damaged or broken by the installation of instrumentation or other accessories or appurtenances.
E. Repair all holidays detected during inspection of coatings.

F. Repair coating where field welds are made or where otherwise damaged or uncoated as follows:
   1. Buried Piping System: Use Protective Coating System E-12A materials and techniques.
   2. Exposed Piping Systems: Use Protective Coating System E-15 or T-1 materials and techniques as applicable.
   3. Complete all weld radiography and other NDE for fuel piping joints prior to application of coatings.

3.05 QUALITY CONTROL

A. Inspection:
   1. Use wet film gauges to check each application about every 15 minutes in order to correct low or heavy film build immediately.
   2. Use dry film gauge to check each coat when dry, and the total system when completed.
   3. Use holiday or pinhole detector on metal systems to detect and correct voids when indicated on system sheet.
   4. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
   5. Check temperature of the substrate at regular intervals to be certain surface is 5ºF or more above the dew point.
   6. Complete coating reports daily using form attached at end of this Section.
   7. A Protective Coating Specialist (PCS) shall be present during all pre-preparation testing, surface preparation, coating application, initial cure of the coating system, and during all coating repair. The PCS shall provide complete documentation of conditions and occurrences on the job site, and notify Engineer of any conditions and/or occurrences that are potentially detrimental to the coating system.

BURNS McDONNELL	PROTECTIVE COATING SYSTEM
	System: E-4

SERVICE:	Internal Pipe Coating, Fuel Systems
Surface Preparation:	SSPC-SP10 with nominal profile depth of 1.5 to 2.5 mils (38 to 63 microns).
General Requirement:	Coating system shall conform the requirements of EI 1541.
First Coat:	High solids, high build, amine-cured epoxy, 55% solids by volume, off-white or similar color. Apply at 5 to 6 mils (125 to 150 microns) dry film thickness. 2" (50 mm) cutback or wipeback at pipe ends.
Second Coat:	Same as first coat, except white color. 2" (50 mm) cutback or wipeback at pipe ends.
System Total:	Minimum 10 mils (250 microns) dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.
Inspection:	Check for voids with suitable electric holiday detector operating at proper voltage.

COATING MANUFACTURER	PRODUCT DESIGNATION	
	FIRST COAT & TOUCH UP	SECOND COAT
PPG	Novaguard 840	Novaguard 840
CARBOLINE	Phenoline 385	Phenoline 385
DEVOE - AKZONOBEL	Devran 744	Devran 744
INTERNATIONAL	Interline 850	Interline 850
SHERWIN-WILLIAMS	Dura-Plate UHS or Phenicon HS	Dura-Plate UHS or Phenicon HS
TNEMEC	Tneme-Liner Series 61	Tneme-Liner Series 61

BURNS McDONNELL	PROTECTIVE COATING SYSTEM System: E-5

SERVICE:	Pipe Coating, Fusion Bonded Epoxy, Exterior of Buried Pipe (Extended to 6" (150 mm) minimum above finished grade or inside vaults)
Surface Preparation:	Shop: Grit blast to SSPC-SP10, with minimum profile depth of 2.5 mils (0.064 mm). Surface shall be clean and dry. Field: Grit blast uncoated or damaged coated area to SSPC-SP6. Surface shall be clean and dry.
General Requirement:	Coating system shall be in accordance with AWWA C213.
First Coat:	Shop applied, fusion bonded epoxy powder. Apply at 20 mils (0.508 mm) minimum dry film thickness. 2" (50 mm) cutback at pipe ends.
Second Coat:	Field applied, two component catalyzed epoxy specifically for use with specified first coat and of same color.
System Total:	20 mils (0.508 mm) dry film thickness.
Inspection:	Check for voids with suitable electric holiday detector operating at proper voltage.

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
Valspar	PipeClad 2000	PipeClad Patch Compound	Per manufacturer
Axalta (DuPont) Nap-Gard Div.	Nap-Gard 7-2500	Per manufacturer	Per manufacturer
3M, Electrical Specialties Div.	Scotchkote 226N or 6233P	Scotchkote 323 or 327	Per manufacturer

BURNS McDONNELL	PROTECTIVE COATING SYSTEM System: E-12

SERVICE: Pipe Wrapping System for Exterior of Buried Pipe
(Used for interfaces between existing coating systems and System E-12A) Where existing pipe having an external coating system other than FBE interfaces with FBE pipe, apply coating system E-12A to bare steel before application of coating system E-12 is applied.

Surface Preparation: Clean free of dirt, mil lacquer, wax, oil, grease, rust, millscale, or other foreign material.

First Coat: Apply primer in a uniform thin film, free of runs, sags, and drips.

Second Coat: Apply polyethylene tape of proper width for pipe size. Clean same as above, apply primer, and polyethylene joint wrap tape in a spiral fashion with 50% overlap. End joint wrap with final edge directed downward.
Tape temperature shall be minimum of 40^{o} F. Overlap end splices 6".

Field Inspection/Repair: Check for voids with suitable electric holiday detector operating at proper voltage.

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	**TOUCH UP**	**SECOND COAT**	**THIRD COAT**
Polyken YG111 Pipeline Coatings Carboline Division, The Kendall Co	Polyken Primer 1033A		Polyken No. 930-35 Joint wrap - 35 mil thickness	
Tapecoat Company	Omniprime		H35 tape wrap - 35 mil thickness	

BURNS McDONNELL	PROTECTIVE COATING SYSTEM System: E-12A

SERVICE:	Pipe Coating System for Exterior of Buried Pipe and Casings (Used for fittings, joints, and repairs)
Surface Preparation:	Clean free of dirt, mil lacquer, wax, oil, grease, rust, millscale, or other foreign material, in accordance with SSPC-SP 10 or as required by coating manufacturer.
First Coat:	Field applied high-solids, fast-drying, surface tolerant epoxy coating. Minimum 78% solids by volume. Apply at minimum of 7 mils dry film thickness per coat.
Second and Third Coats:	Same as first coat.
Total System:	20 mils minimum dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.
Field Inspection/Repair:	Check for voids with suitable electric holiday detector operating at proper voltage.

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	**SECOND COAT**	**THIRD COAT**
Carboline - SPC	SP-2888	Same as first coat	Same as first coat
3M (for use with 3M external fusion bonded epoxy coating systems)	Scotchkote 323P	Same as first coat	Same as first coat
PPG	Amercoat 240	Same as first coat	Same as first coat
Chase Corporation	TC 7100	Same as first coat	Same as first coat
Denso North America Inc.	Protal 7200	Same as first coat	Same as first coat

NOTE: Confirm E-12A is compatible with E-5 coating system used on project – confirm with E-5 system manufacturer.

BURNS McDONNELL	PROTECTIVE COATING SYSTEM
	System: T-1

SERVICE:	Steel Storage Tanks – Exterior of Tanks, Aboveground Piping, Fuel Equipment, Etc. Coating System Field Applied
Surface Preparation:	Field First Coat: SSPC-SP6 1.5 to 2.5 mil profile (38 to 63 microns)
First Coat:	High build, high solids polyamide, polyamine, or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 to 6.0 mils (100 to 150 microns) dry film thickness.
Second Coat:	High build, high solids polyurethane low sheen enamel with minimum 60% solids by volume. Apply at 4.0 to 5.0 mils (75 to 125 microns) dry film thickness.
System Total:	Minimum 8.0 mils (0.229 mm) dry film thickness.
Volatile Organic Content:	Maximum per local regulatory requirements.

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
PPG	Amerlock 600	Same as first coat	Pitthane Ultra LS
Carboline	Carboguard 890	Same as first coat	Carbothane 133 Series
Devoe – AkzoNobel	Devran 224HS	Same as first coat	Devthane 378
International	Intergard 345	Same as first coat	Interthane 870 HS, semi-gloss
PPG	Multi Prime EFD 94-109	Same as first coat	Pitthane 95-8800 Series
Sherwin-Williams	Recoatable Epoxy Primer B67 Series	Same as first coat	Acrolon 218 HS B65-650 Series
Tnemec	Epoxoline II N69	Same as first coat	Endura-Shield II, Series 1075

BURNS McDONNELL	PROTECTIVE COATING SYSTEM System: T-2

SERVICE:	Steel Fuel Storage Tanks – Interior Lining for Jet Fuel Storage Coating System Field-Applied
Surface Preparation:	Field First Coat: SSPC-SP10 and profile depth of 1.5 to 2.5 mils (38 to 63 microns).
General Requirement:	Coating system shall conform the requirements of EI 1541.
First Coat:	High solids amine or phenolic epoxy with minimum of 69% solids by volume. Apply at a minimum of 5.0 to 6.0 mils (125 to 150 microns) dry film thickness per manufacturer's recommended thickness.
Second Coat:	Same as first coat except color shall be different than first coat to distinguish between coats. Second coat shall be white, light gray, or beige for light reflectance and to facilitate inspection.
System Total:	Minimum 10.0 mils (250 microns) dry film thickness. Check for voids with holiday or pinhole detector.
Volatile Organic Content:	Maximum per local regulatory requirements.

COATING MANUFACTURER	**PRODUCT DESIGNATION**	
	FIRST COAT	**TOUCH UP**
PPG	Amercoat 240	Amercoat 240
Carboline	Phenoline 385	Phenoline 385
Devoe – AkzoNobel	Interline 984	Interline 984
Sherwin-Williams	Dura-Plate UHS	Dura-Plate UHS
Tnemec	Tneme-Liner 61	Tneme-Liner 61
Alternate Systems		
International	Interline 850	Interline 850
ITW Devcon Futura	Ultra-Line 368 Primer	Ultra-Line 368 Finish

BURNS McDONNELL

PROTECTIVE COATING SYSTEM

System: T-3

SERVICE: Steel Storage Tanks - Exterior of Tanks
Finish Coat Field Applied:

Surface Preparation: Field First Coat: SSPC-SP6 1.5 to 2.5 mil profile
Field Applied First Coat at joint areas and Touch-up: SSPC-SP11

First (prime) Coat: Shop Applied (Optional Field Applied): High build, high solids polyamide, or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 to 5.0 mils dry film thickness.

Second Coat: Field Applied: Same as first coat.

Third Coat: Field Applied: High build, high solids, polyurethane gloss enamel with minimum 60% solids by volume. Apply at 4.0 to 5.0 mils dry film thickness. If environmental conditions are such that rolling is required, several coats may be required to achieve specified DFT.

System Total: Minimum 12.0 mils dry film thickness.

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	**TOUCH UP**	**SECOND COAT**	**THIRD COAT**
PPG	Amercoat 385	Same as first coat	Amercoat 385	Amershield
Carboline	Carboguard 893 Series	Same as first coat	Carboguard 893 Series	Carboguard 133 HB
Ceilcote	615 Ceilgard	Same as first coat	615 Ceilgard	477 Ceilgard
Devoe – AkzoNobel	Devran 220	Same as first coat	Devran 220	Devthane 359
ITW Devcon Futura	Flexshield Primer 4484	Same as first coat	Flexshield Primer 4484	Flexshield 1000
Sherwin-Williams	Recoatable Epoxy Primer B67 Series	Same as first coat	Same as first coat	HS Polyurethane B65-300 Series
Tnemec	Epoxoline II-N69	Same as first coat	Epoxoline II-N69	Endura-Shield II 1074
Alternate System:				
International	Interseal 670 HS	Same as first coat	Interseal 670 HS	Interthane 870

END OF SECTION 33 52 46

COATING REPORT

Contract Name: _____ Contract No.: _____
Coating Contractor: _____ Foreman: _____

Unit or Surface Identification: _____
Unit or Surface Location: Exterior _____, Interior _____

Surface Preparation:
Date _____; Air Temp _____ºF; Relative Humidity _____%
Method of Surface Preparation: _____
Profile achieved _____ mils (if applicable).

Touch-Up:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity_____%; Dew Point _____ºF
Coating Used _____; Dry Film Obtained _____ mils.

First Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

Second Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

Third Coat:
Date _____; Time _____; Air Temp _____ºF; Surface Temp _____ºF
Relative Humidity _____%; Dew Point _____ºF
Coating Used _____; Dry Time Before Recoat _____ hrs.
Dry Film Obtained _____ mils.

SECTION 33 52 47 – FUEL SYSTEM VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers valves applicable to the fuel system.

B. Extent of Work shall be as follows:

1. All special valves, pilots, fittings, equipment and related items, shall meet the following requirements:
   a. Be furnished, installed, tested, and put into successful operation.
   b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and related items, whether shown on the Drawings or not, but required.
   c. Meet the requirements of applicable codes and standards as specified.
2. Piping connected to Equipment which must vary from the Drawings shall be furnished and installed as required to make a complete and workable installation. This requirement includes changes due to the selection of a different Equipment manufacturer than what is indicated on the Drawings, specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
3. Control Valves: Furnish complete with pilots, couplings, tubing, etc.
4. Spare, Replacement, or Additional Parts:
   a. Where spare, replacement, or additional parts are required for the Equipment specified herein, these items shall be delivered to Owner immediately upon receipt at the Site.
   b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
   c. Provide an inventory list of the items delivered to Owner.

C. This Section covers valves related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, 0ºF to 100ºF, and having a specific gravity of 0.81.

D. All supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

1.03 RELATED REQUIREMENTS:

A. Section 33 52 43 - Fuel System General Requirements.
B. Section 33 52 45 - Fuel System Pipe, Connections, and Installation.
C. Section 33 52 44 - Identification of Fuel Piping and Equipment.
D. Section 33 52 48 - Fuel System Accessories.
E. DIVISION 26 - Electrical Work.

1.04 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American Society for Testing and Materials (ASTM):
   1. A216 – Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
C. American Society of Mechanical Engineers (ASME):
   1. B16.34 - Valves - Flanged, Threaded and Welding End.
   2. BPVC Section VIII, Division 1 – Rules for Construction of Pressure Vessels.
D. American Petroleum Institute (API):
   1. SPEC 6FA - Specification for Fire Test for Valves.
   2. STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-welding.
   3. STD 600 - Steel Gate Valves, Flanged and Butt-welding Ends, Bolted Bonnets.
   4. STD 607 - Fire Tests for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats.
   5. STD 609 - Butterfly Valves, Double-flanged, Lug and Wafer-type.
E. Military Specifications:
   1. MIL-STD-810G - Environmental Engineering Considerations and Laboratory Tests.
F. National Electrical Manufacturers' Association (NEMA).

1.05 SUBMITTALS:
A. Submit as specified in Section 33 52 43.

1.06 QUALITY ASSURANCE:
A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide products by one of the following:
   1. Ball Valves:
      a. FloTite.
      b. Velan.
      c. Worcester Controls.
      d. WKM.
      e. Watts.
      f. Jamesbury.
      g. Approved equal.
   2. Butterfly Valves:
      a. WKM.
      b. Keystone.
      c. Approved equal.
      d. Note: Butterfly valve electric actuators to be provided by valve supplier.
   3. Check Valves (Socket Welded or Flanged - Small Bore):
      a. Velan.
      b. Crane.
      c. Jenkins.
      d. Bonney Forge.
      e. Gammon Technical Products (Model GTP-1294, SS valve - these valves are threaded and only allowed for filter vessel automatic air vent discharge).

f. Approved equal.

4. Center-Guided Check Valves (Lugged Body Wafer Style):
   a. DFT (Model TLW).
   b. Approved equal.
5. Thermal Relief Valves:
   a. Taylor Valve Technology, Inc.
   b. Hydroseal.
   c. Approved equal.
6. Double Block and Bleed (DBB) Plug Valves:
   a. Cameron (General Twin Seal).
   b. Western Valve (Dan-Ex).
   c. Approved equal.
7. Electric Valve Actuators (DBB Plug Valves):
   a. Rotork.
   b. Limitorque.
   c. EIM.
   d. Auma.
8. Automatic Recirculation Valves:
   a. HBE.
   b. Yarway.
9. Instrument Valves:
   a. Anderson, Greenwood & Co. (Model M9-VDC-44).
   b. NOSHOK.
   c. Approved equal.
10. Control Valves:
    a. OCV.
    b. Cla-Val.
    c. Brodie.
11. Hydrant Valves:
    a. Carter (60554AEX).
    b. Whittaker Controls, Inc. (F353AF).
    c. Cla-Val (352GF).

2.02 BALL VALVES:

A. Valve body shall be of carbon steel with 316 stainless-steel ball and stem.
B. Valve shall be rated for 275 psig working pressure and bubble-tight at differential pressure of 275 psid.
C. Valves 2-1/2-inch size and smaller shall be of three-piece bolted construction, with socket weld end connections unless indicated or specified otherwise. Standard or extended socket weld end connections are acceptable. Drain and vent valves discharging to atmospheric pressure shall be socket weld by threaded end (threads on atmospheric side).
D. All valves in pits or vaults and valves in other locations 3-inch size and larger shall be of two-piece split body construction, with flanged end connections unless indicated otherwise.
E. Seals and/or seats shall be reinforced PTFE. Graphite stem seal to meet API fire safe requirement.
F. Provide with a vinyl-coated, locking handle suitable for padlocking. Valves 6-inch size and larger shall be provided with a closed case gear operator.
G. Valves shall be certified "fire safe" per API STD 607.
H. Where noted, valves shall have quick closing spring return handle.

2.03 CHECK VALVES:

A. Lift-type check valves (smaller than 2-inches):
   1. Forged carbon steel, bolted bonnet, Class 800, lift check.
   2. Elastomers shall be compatible with jet fuel.
   3. End connections shall be socket welded or flanged.

B. Center-guided check valves (2-inches and larger):
   1. Valve shall be non-slam, spring-assisted, center-guided, threaded lug, wafer-style suitable for 275-psig working pressure, designed and tested to API STD 594.
   2. Valve body shall be carbon steel with 316 stainless-steel disc and bushing.
   3. Valve seat shall be resilient Viton F.
   4. Valve spring material shall be Inconel.
   5. Ends shall be suitable for installation between Class 150 raised-face flanges.
   6. If valve is to be installed in vertical piping, coordinate with manufacturer to ensure appropriate valve internals/springs are provided for vertical orientation.

2.04 THERMAL RELIEF VALVES:

A. Carbon-steel body, stainless-steel internals, disc, and seat type, Viton elastomers (seat, O-ring), closed cap (no lever).

B. Valves shall include ASME, BPVC Section VIII code stamp, except for “balanced” type thermal relief valves as specified below.

C. Valves shall be set to relieve at setpoint indicated on drawings.

D. All set points shall be a nominal point within a "SET POINT" range, adjustable for field conditions.

E. Where indicated or specified, provide "balanced" type thermal relief valves, which shall open at setpoint regardless of downstream pressure.

F. Inlet and outlet shall be 1-inch, with flanged connections.

2.05 DOUBLE BLOCK AND BLEED (DBB) PLUG VALVES:

A. Valve body shall be steel with reduced port configuration and chrome-plated bore. Valve plug shall be chrome or nickel plated. Valve port openings shall be approximately 70% free area of pipe size installed in.

B. The valve assembly shall include a manual bleed valve and a thermal relief valve discharging upstream of valve throat.

C. Slip seals and valve O-rings shall be Viton.

D. Valve shall be fire tested and qualified to API SPEC 6FA. Valve shall be rated for 275-psig working pressure.

E. Gear operators shall be provided for valves 6-inches and larger.

2.06 ELECTRIC VALVE ACTUATORS FOR DBB PLUG VALVES:

A. General: Actuators, their controls and accessories shall be the responsibility of the valve/actuator supplier for sizing, assembly, certification, field testing, and any adjustments necessary to operate the valve as specified. The electric valve actuators shall include as an integral unit, but not be limited to, the electric motor, actuator unit gearing, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, wiring terminals for power, remote control and indication connections, and handwheel.

B. Power Supply: Actuators shall be suitable for use on nominal 480V, 3-phase, 60-Hz power supply.

C. The actuator must be capable of operating in an ambient temperature ranging from -30°C to 70°C, 100% relative humidity.
D. Opening/Closing Speed:
   1. Maximum closure time from fully open to fully closed: 60 seconds, unless special operating conditions are specified.
E. Enclosure:
   1. The valve actuator motor and all electrical enclosures shall be non-intrusive, suitable for operation in a Class I Division 1 Groups C and D outdoor location.
   2. The valve actuator shall be suitable for mounting in the vertical or horizontal positions as required.
F. Motor:
   1. The electric motor shall be specifically designed for valve actuator service and shall be of high starting torque, totally enclosed, nonventilated construction.
   2. Motor insulation shall be a minimum NEMA Class F, with a maximum continuous temperature rating of 155ºC (rise plus ambient) for the duty cycle specified.
   3. The motor shall be of sufficient size to open or close the valve at the maximum stated torque. The motor shall be capable of complete operation at ±10% of specified voltage. The motor duty rating shall be sufficient for one complete cycle (open-close-open, or close-open-close) without exceeding its temperature rating or rated to allow 15-minute operation at 33% of maximum rated torque without exceeding its temperature rating. Motor bearings shall be of the antifriction type and permanently lubricated.
   4. The motor shall be an independent removable subassembly to allow for motor or gear or ratio changes dictated by system operation requirements.
   5. The motor shall be equipped with internal thermal sensors embedded in the windings to protect against motor overload. If the motor/integral control area is not served by a common space heater, one shall be provided in the motor. Space heaters shall be powered via the motor input power supply.
   6. Motors shall be suitable for pulse opening and closing speed, adjusted by the actuator's integral microprocessor-based controls.
G. Integral Starter and Transformer:
   1. The reversing contactor starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation buildup.
   2. The starter shall be suitable for 60 starts per hour and shall comprise mechanically and electrically interlocked reversing contactors of rating appropriate to motor size.
   3. The controls supply transformer shall be fed from two of the incoming three phases. It shall have the necessary tappings and be adequately rated to provide power for the following functions:
      a. 120Vac energization of the contactor coils (open/close/maintain/common).
      b. 120Vac ESD.
      c. 120Vac position indication (open/close).
      d. 120Vac trouble alarm.
      e. Supply for local controls and indication and, where required, for remote control.
   4. The primary and secondary windings shall be protected by easily replaceable cartridge-type fuses.
H. Power Gearing:
   1. The actuator shall be a single or multiple reduction unit with power gearing consisting of spur, helical, or bevel gears and/or worm gearing. The spur, helical, or bevel gearing and worm shall be of hardened alloy steel, and the worm gear shall be alloy bronze. All

gearing shall be accurately cut. Nonmetallic aluminum or cast gearing shall not be allowed.

2. All gears and shafting shall be supported on anti-friction bearings. Where thrust is a consideration, tapered roller bearings (to accept thrust) shall be provided.

I. Lubrication:
   1. All rotating power train components shall be immersed in grease or oil with provisions for inspection and relubrication without disassembly.
   2. Seals shall be provided at all exit points of the gear case to prevent leakage of lubricant. Critical areas subject to high wear shall be double sealed.
   3. Lubricants shall be suitable for ambient conditions of -20ºF to 150ºF.

J. Lost-Motion Device:
   1. The actuator shall have a built-in device (independent of gear backlash), incorporated in the power train, to permit load impact under dynamic efficiency conditions, with a hammer blow effect, to allow the motor to reach full speed before engaging the valve load.

K. Manual Operation:
   1. Integral to the actuator shall be local controls comprising push-button switches for Open, Close, and Stop, and a Local/Remote/Stop (Off) selector switch. Selector switch shall be padlockable in any one of the following three positions: Local control only, Remote, Stop (no electrical operation), Remote control plus local stop only.
   2. A metallic handwheel shall be provided for manual operation. An arrow and the word "open" to indicate open rotation direction shall be provided. The handwheel shall operate in the clockwise direction to close. The handwheel shall not rotate during motor operation and operation by handwheel shall not cause the motor to rotate.
   3. A fused motor shall not prevent manual operation.
   4. When in the manual operating mode, the actuator will remain in this mode until the motor is energized, at which time the actuator will automatically return to electric operation. Use of the handwheel shall not negate the hammer blow feature.
   5. The handwheel shall require an effort of no more than 80 pounds on the rim for seating or unseating load, or 60 pounds for running load.
   6. Movement from motor operation to handwheel operation shall be accomplished by a positive declutch lever which mechanically disengages the motor and related gearing. Declutch lever shall be padlockable in either the manual (handwheel) or motor mode.
   7. It shall be impossible for simultaneous manual and motor operation to occur. Friction type declutch mechanism is not acceptable.

L. Stem Nut:
   1. The valve actuator shall have a removable stem nut (or drive bushing) of high tensile bronze or other material compatible with the valve stem material.

M. Position Limit Switches:
   1. Position limit switches and the associated gearing shall be an integral part of the valve actuator. Limit switch gearing shall be functional at all times, whether the unit is operated electrically or manually.
   2. Gearing shall be made of bronze or stainless steel, grease lubricated, and totally enclosed to prevent dirt and foreign matter from entering the gear train.
   3. Switches shall be field adjustable, allowing for trip points from fully open to fully closed positions or any intermediate point of valve travel. They shall not be subject to breakage or slippage due to over-travel.
   4. Limit switch contacts shall be heavy-duty, silver or silver plated having a minimum rating of 5 amperes (break) inductive at 120Vac, with wiping action.

5. Contacts shall be convertible from N/O to N/C or reverse. Use of cams or set screws in securing switches or the drive system is unacceptable.
6. Provision shall be made for the future addition of a minimum of two additional limit switches.
7. Switch design shall permit visual verification of switch position without disassembly.

N. Torque Switch:
1. Each valve actuator shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs or when valves require torque seating in the closed or open position.
2. Contacts shall be silver or silver plated having a minimum rating of 5 amperes (break) inductive at 120Vac.
3. The torque switch shall be independently adjustable for both open and close directions of travel, with a positive means to limit the adjustability so as not to exceed the actuator output torque capability.
4. Switch design shall permit visible verification of switch position without disassembly.

O. Control Compartment Heating:
1. The control compartment shall be provided with a space heater suitable for operation from the motor power supply power. Space heater shall be adequately rated for the classified area or not exceed 80% of the autoignition temperature of Jet A.

P. Start-Up Kit:
1. Each actuator shall be supplied with a start-up kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

Q. Actuator Operating Conditions:
1. Actuators shall be capable of operating with a 275-psi upstream to downstream line pressure differential, with corresponding 275-psig upstream and 0-psig downstream pressures, while complying with handwheel requirements specified under "Manual Operation" above. Actuators for the 20-inch valves adjoining tank suction nozzle connections shall be capable of operating with a 100-psi upstream to downstream line pressure differential, while complying with handwheel requirements.

R. Performance Test Certificate:
1. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load and the following parameters shall be recorded:
    a. No load current.
    b. Current at max torque setting.
    c. Stall current.
    d. Torque at max torque setting.
    e. Stall torque.
    f. Test voltage and frequency.
    g. Flash test voltage.
    h. Actuator output speed.
2. In addition, the test certificate shall record details of specification such as gear ratios for both manual and automatic drive, closing direction, wiring diagram code number, and when applicable, remote position transmitter resistance and interposing relay voltage.

S. Microprocessor-Based Controls:
1. General:
    a. Each valve actuator shall be provided with an electronic, microprocessor-based control unit (field unit) as an integral part of the valve actuator enclosure.

b. Field unit shall be connected to a two-wire communications bus system.
c. If required, the master station shall communicate with the PLC. Communications shall include all valve position and control functions and alarm conditions as indicated in this Specification.
d. Integrity of data transmission between the PLC and various system components shall be ensured by error checking procedures.
e. Provide all software and hardware required for communications with PLC and/or PC. Indicate minimum hardware and software requirements for the PLC or PC, if any.
f. Communications will be under the supervision of the Systems Integrator defined in Section 25 50 01 – Facility Controls for Fuel Systems.
g. DBB Special Operating Conditions for EFSO Condition: DBB Plug valves shall "quarter turn" closed no sooner than 15-seconds and full speed thereafter. The two-speed operation shall be accomplished through settings within the actuator's integral microprocessor, or by other methods approved by the Engineer.
h. All electric valve actuators shall include the pulse feature/option (Interrupter Timer) for adjusting the rate or speed of valve opening and closing through the actuator's integral microprocessor controls.

2. Field Unit:
   a. Ambient operating temperature range: -30 to +70ºC.
   b. Storage temperature range: -40 to +80ºC.
   c. Power Supply: From valve actuator.
   d. Plant induced vibration withstand capability per MIL-STD-810G method 514.6, and single shock load capability per MIL-STD-810G method 516.6.
   e. Humidity Range: 5% to 95% noncondensing.
   f. Digital inputs from actuator including, but not limited to, reversing starter, limit switches, torque switches, push buttons, selector switch, and motor thermal contacts.
   g. Field addressable.
   h. Local indication of relay and data transmission status.
   i. Emergency shutdown position selection.
   j. Surge/lightning protection provided on all input and output field and data ports.
3. Master Station (if required):
   a. Ambient operating temperature range: 0 to +50ºC.
   b. Storage temperature range: -10 to +70ºC.
   c. Power Supply: 115Vac (+10% to -20%), 45-65 Hz.
   d. Plant induced vibration withstand capability per MIL-STD-810G method 514.6, and single shock load capability per MIL-STD-810G method 516.6.
   e. Humidity Range: 5% to 95% noncondensing.
   f. One master station shall be capable of monitoring and controlling all actuators.
   g. Surge/lightning protection provided on all input and output field and data ports.
   h. Baud Rate: Provide such that no more than 3 seconds elapse between successive interrogations of the same actuator.
4. Field Unit Test/Troubleshoot Terminal:
   a. Provide one portable terminal capable of providing local control, test, and troubleshooting functions at individual actuators. Unit shall be non-intrusive, suitable for use in Class I Division 2 locations.

T. Manufacturer's Field Engineer: The services of an experienced service engineer shall be provided by the Supplier to verify proper installation, calibrate instrumentation, assist in start-up and testing, and instruct Owner's operating personnel.

2.07 AUTOMATIC RECIRCULATION VALVE:

A. General Information: Valve shall provide minimum recirculation flow specified by the pump manufacturer to protect the Reclaim/HCTS pump (TP-1) system pumps from cavitation and pump dead heading.

B. Performance Characteristics:
   1. Valve shall be totally mechanical self-powered design with no linkages, control signals, or pilot valves.
   2. Manufacturer shall coordinate with pump supplier and obtain certified performance data and curves, indicating discharge pressure, capacity, speed, suction pressure, and minimum recirculation flow for the pumps submitted and approved for the fueling system. Valve manufacturer shall submit documentation confirming that this coordination has been performed.
   3. Valve shall modulate between full recirculation flow at zero system demand and zero recirculation at full system demand.
   4. Provide valve to produce stable operation throughout operating flow range. If required for stable bypass operation, an orifice plate shall be provided in each individual pump recirculation line, along with a set of companion flanges for installation. Provide any field modifications required to produce stable operation of the valve and pump combination, such as resizing of the orifice or the valve internals.

C. Tests: Individual flow tests shall be performed on each valve and certified curves shall be provided.

D. Construction:
   1. All seals and materials shall be suitable to be in contact with aviation Jet A fuel with a specific gravity of 0.81.
   2. Valve shall be the product of a U.S. manufacturer in full compliance with ASME B16.34 requirements for material, welding, and testing.
   3. Valve body shall be carbon steel.
   4. Flanges shall be ASME Class 150 raised face.

2.08 INSTRUMENT (NEEDLE) VALVES:

A. Shall have a replaceable seat insert of Delrin and Teflon stem packing.

B. Body shall be carbon steel, with working pressure of 3,000 psi.

C. Shall have a needle type bleed valve.

D. End connections shall be screwed.

2.09 CONTROL VALVES:

A. General Requirements:
   1. All control valves provided shall be from same manufacturer.
   2. Diaphragm or balanced piston type valve designed for service as specified below.
   3. Valve and all components shall be suitable for turbine jet fuel and a working pressure of 250 psig at 100ºF.

B. Construction:
   1. Body shall be ductile iron suitable for a working pressure of 250 psig at 100ºF.
   2. Piping connection shall be ASME B16.5 Class 150 with raised-face flanges. Size shall be as indicated on Drawings.

3. Main valve trim, seats, guides, control pilots, and tubing systems shall be stainless steel.
4. Elastomers shall be suitable for service in Jet A turbine fuel.
5. Wettable main valve body surfaces shall be electroless nickel plated.
6. Provide one or more in-line strainers in valve pilot tubing to prevent potential fouling of pilot controls.
7. Performance characteristics and accessories shall be as noted in the following paragraphs.
8. Orifice plate holders shall be cast steel or ductile iron and have a minimum working pressure equal to that of the associated control valves. Orifice plates shall be stainless steel.
9. Solenoid valves shall be UL-listed for Class I, Division 1, Group D locations.

C. Manufacturer's Service Engineer:
1. Furnish the services of an experienced service engineer on the Job Site to verify proper installation and assist in start-up, check-out, and calibration. Allow for separate trips to the Site if required by the construction schedule or Owner's operations.
2. Furnish the services of an experienced service engineer to instruct Owner's operating personnel on proper operation, maintenance, and repair of equipment. This instruction time and trip to the Site shall be in addition to the requirements of "1." above.

D. Specific Requirements:
1. Water slug valves (RFCV-1 and RFCV-2) - Shall be located downstream of filter/separator and close by electric signal upon detection of water by the water detection probe (moisture switch) contained within the filter/separator sump. Valve shall be normally closed, flow to open. Valve shall limit flow rate to 1,000 gpm. Provide the following trim/accessories:
   a. Explosion proof, 120Vac control solenoid pilot valve, with maintained position type manual override. Solenoid valve shall be UL-listed.
   b. Rate of flow pilot with orifice plate and sensing lines completely piped and self-contained on valve.
   c. Opening and closing speed adjustment.
   d. Integral and independent check feature.
   e. Independent differential pressure pilot to keep valve "in control" at reduced flows (5- to 15-psi adjustable setpoint)
2. Offload Control Valve (OCV-1 and OCV-2) - Shall be located downstream of the offloading pumps OP-1 and OP-2. Valve shall be normally closed, flow to open. Valve shall limit flow rate to 450 gpm. Provide the following trim/accessories:
   a. Rate of flow pilot with orifice plate and sensing lines completely piped and self-contained on valve.
   b. Opening and closing speed adjustment.
   c. Integral and independent check feature.
   d. Independent differential pressure pilot to keep valve "in control" at reduced flows (5- to 15-psi adjustable setpoint)
3. Tank High Level Shut-off Valves (HLCV-1) - Shall be hydraulically operated and shall be provided with a tank-mounted float controller. The activation point of the float for opening and closing the high liquid level shut-off valve shall be determined in coordination with Engineer. Upon a rise in fluid level to the float activation point, the float control system shall cause the main valve to close tightly. The main valve shall remain closed until a drop in the tank fluid level occurs. Upon a drop in fluid level beneath the float activation point, the float control shall allow the main valve to open completely. Valve shall limit flow to 1,000-gpm and be normally closed, flow to open. Provide the following trim/accessories:

a. Integral check feature.
b. Rate of flow pilot with orifice plate at valve exit and sensing lines completely piped and self-contained on valve.
c. Single-pole double-throw limit switch for valve position indication mounted in NEMA 4, NEMA 7 enclosure.
d. Closing speed adjustment.
e. Manual Test Feature: Manual testing of high level shut-off valve and float's automatic opening and closing feature shall be provided.
f. Provide shut-off cocks, high point vents and low point drains in pilot tubing, for ease of start-up, testing, and maintenance. Completely purge pilot tubing of air, water, and material.

2.10 HYDRANT VALVE:

A. Valve shall be 4-inch cast ductile-iron body with Class 150 ASME inlet flange, and outlet adapter shall conform to API Bulletin 1584, 4th Edition.
B. Valve shall have an air-operated pilot valve, to open and close valve.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Inspect valve for cleanliness, corrosion, and operability. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.
B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve's closure member to the shipping position.
C. Examine threads or flanges on both the valve and the mating pipe for form (i.e., out-of-round or indentation) and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, defects, and damage.
E. Prior to valve installation, examine the pipe for cleanliness and proper alignment.
F. Replace defective valves with new valves.

3.02 VALVE ENDS SELECTION:

A. Unless indicated or specified otherwise, select valves with the following end connections.
1. Sizes 2-1/2 inches and smaller shall be socket weld or flanged. Drain and vent valves discharging to atmospheric pressure shall be socket weld by threaded end connections (threads on atmospheric side) or flanged.
2. Sizes 3 inches and larger: Flanged.

3.03 ADJUSTMENTS AND CALIBRATION:

A. Adjust all valves for the flows, level settings, and pressure settings indicated and specified.
B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed.
C. Final adjustments shall be made with system in operation during system commissioning. Check all valve settings frequently following final adjustment to monitor for potential drift. Adjustments back to original setting shall be performed immediately if drift occurs.
D. Modify adjustments during start-up, including flow rates, pressure settings, meter settings, and other variables as required.

3.04 TUBING INSTALLATIONS:

A. Assemble and tighten fittings as recommended by the manufacturer.
B. Route as required to interconnect the instrumentation provided.
C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system.

3.05 VALVE AND EQUIPMENT INSTALLATION:

A. Install where indicated on the Drawings and in accordance with manufacturer's recommendations.
B. Replace any and all valves and equipment that prove defective during testing. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.
C. Install all butterfly valves with the disc shaft in the horizontal axis.
D. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.
E. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.06 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all equipment items thoroughly before operating or testing.
B. Protect equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.07 EQUIPMENT TEST AND CHECKOUT:

A. Before equipment installations will be accepted, the equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of the manufacturer shall be carried out completely.
C. All tested equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item shall be repaired or replaced and put into proper operation by Subcontractor immediately.
E. Protect all equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF SECTION 33 52 47

SECTION 33 52 48 - FUEL SYSTEM ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers special Equipment and mechanical accessories applicable to the fuel system.

B. Extent of Work shall be as follows:

1. All special valves, pilots, fittings, equipment, and related items shall meet the following requirements:
   a. Be furnished, installed, tested, and put into successful operation.
   b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and other items, whether shown on the Drawings or not, but required.
   c. Meet the requirements of applicable codes and standards as specified.
2. Piping connected to Equipment which must vary from the Drawings shall be furnished and installed as required to make a complete and workable installation. This requirement includes changes due to the selection of a different Equipment manufacturer than what is indicated on the Drawings, specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
3. Spare, Replacement, or Additional Parts:
   a. Where spare, replacement, or additional parts are required for the equipment specified herein, these items shall be delivered to the Owner immediately upon receipt at the Site.
   b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
   c. Prepare an inventory list of the items delivered to Owner.

C. This Section covers fittings, meters, and accessories related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, -20ºF to 100ºF, and having a specific gravity of 0.81.

1.02 RELATED REQUIREMENTS:

A. Section 33 52 43 – Fuel System General Requirements.

B. DIVISION 26 – Electrical Work.

1.03 REFERENCES:

A. American Society for Testing and Materials (ASTM):
   1. A53 - Pipe, Steel, Blade and Hot-Dipped, Zinc-Coated Welded and Seamless.

B. American Society of Mechanical Engineers (ASME):
   1. B16.11 - Forged Fittings, Socket-Welding and Threaded.
   2. Section VIII of Code.

C. American Petroleum Institute (API):
   1. RP 1004 – Bottom Loading and Vapor Recovery for MC-306 & DOT-406 Tank Motor Vehicles.

D. Energy Institute (EI).
   1. 1529 - Aviation Fuelling Hose and Hose Assemblies.
   2. 1581 - Specifications and Laboratory Qualification Procedures for Aviation Fuel Filter/Water Separators.
   3. 1584 – Four-inch Hydrant System Components and Arrangements.

E. Military Specifications:
   1. MIL-C-4556 - Coating, Kit, Epoxy for Interior of Steel Fuel Tanks.
   2. MIL-R-6855 - Rubber, synthetic, sheets, strips, molded or extruded shapes.
F. National Electrical Manufacturers' Association (NEMA).
G. Local governing code.

1.04 QUALITY ASSURANCE:

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves and Equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
B. All supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS

MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Quick Couplings:
      a. OPW.
         (1) Open Camlock (Model 633-A with Model 634-B dust cap).
         (2) Dry break (Model 1611-A dry break with Model 634-B dust cap).
      b. Approved equal.
   2. Sight Flow Indicators:
      a. OPW ("Visi-Flo," Type 1521).
      b. Approved equal.
   3. Fuel Sampling Connections:
      a. Gammon Technical Products, Inc. (Kit No. 7).
      b. Approved equal.
   4. Pressure Gauges:
      a. Reotemp Instruments.
      b. Approved equal.
   5. Meter Prover Connection:
      a. OPW (Model 633-A adaptor with 634-B cap).
      b. Approved equal.
   6. Jet Fuel Hose:
      a. Parker.
      b. Hewitt.
      c. Approved equal.
   7. Hydrant Cart/Refueler Test Stand – Aircraft Fueling Adapter:
      a. Whittaker Controls, Inc. (F418).
      b. Approved equal.
   8. Meters:
      a. Brodie.

b. Approved equal.

9. Sump Separators:
   a. Schultz Engineered Products, Inc.
   b. Approved equal.
10. Automatic Air Vent:
   a. Armstrong.
   b. Approved equal.
11. Ball Joints:
   a. Hyspan/Barco.
   b. Approved equal.

2.02 QUICK COUPLING:

A. Shall be a quick break coupling adaptor and dust cap, size as indicated.
B. Quick coupling adaptors located on connections to hydrant system piping shall be dry break type.
C. Construction of adaptor and cap shall be aluminum.

2.03 SIGHT FLOW INDICATORS:

A. Indicators shall have two viewing windows of high strength tempered windows and Viton window gaskets. Indicator shall have a propeller.
B. Cast-steel body shall be suitable for 275-psi working pressure.
C. End connections shall be ASME Class 150 raised face flanged.

2.04 FUEL SAMPLING CONNECTIONS:

A. Kit shall include stainless steel probe, ball valve and dry break quick coupler with chain-affixed dust plug of aluminum.
B. Shall be suitable for sampling aviation jet fuel from piping systems or Equipment. Sampling connection shall be installed on side of pipe, not top or bottom.

2.05 PRESSURE GAUGES:

A. All pressure gauges shall be silicon-filled type and shall have all internal parts immersed.
B. Gauges shall have 4-inch dials, 1/2-inch NPT lower stem, 316SS tube/socket and stainless steel case, and shall be mounted to the pipe by means of the instrument valves specified.
C. Gauges shall be graduated as indicated on the drawings.

2.06 METER PROVER CONNECTION:

A. Adaptor and cap shall be aluminum.
B. Adaptor shall be 4 inches in size of aluminum construction.
C. Adaptor connection shall be 4-inch NPT.

2.07 JET FUEL HOSE:

A. Hose shall be 4-inch diameter as required.
B. All hoses shall meet NFPA 407 requirements.
C. Tube shall be nitrile with high-tensile cord reinforcement interwoven hardwall construction. Cover shall be black neoprene.
D. Unloading/suction hose shall be EI 1529 Type E, Grade 2, capable of 300 psi working pressure and vacuum pressure to 8 inches Hg.

2.08 AUTOMATIC AIR VENT:

A. Automatic air vent shall have stainless or carbon steel body and cover, stainless steel float, and Buna-N seat.
B. All non-stainless steel wettable surfaces shall be epoxy coated conforming to MIL-PRF-4556.
C. Automatic air vent shall be provided with an air (vacuum) check valve on the discharge to prevent air from re-entering the system during negative pressure conditions. Air check valve shall be stainless steel.
D. A manual air vent and ball valve shall be provided between the automatic air vent and the upstream piping. Manual air vent shall include a tee connection with a ball valve as specified herein and threaded plug.

2.09 HYDRANT CART TEST CONNECTION-AIRCRAFT FUELING ADAPTER:

A. Connection shall be 2-1/2-inch international standard 3-lug bayonet flange, and mounting connection shall be 4-inch, ASME Class 150 flange.
B. Provide plastic dust covers.
C. Body shall be of aluminum construction.

2.10 METERS:

A. General Requirements: Positive displacement meters designed to meter product at the specified flow rate, and API gravity as listed in Meter Chart in this Section.
B. Construction:
   1. Meters shall be of double case, positive displacement, straight through design.
   2. Outer housing and cover shall be cast steel.
   3. Inner housing and rotor shall be cast iron or aluminum.
   4. Packing gland shall be steel and Teflon.
   5. Meter and all components shall be capable of 150 psig working pressure.
   6. Meter sizes, performance, and accessories shall be as shown below in Meter Data.
   7. Meter shall include an illuminated backlit, two line, 16-digit display for flow rate and total, and include zero and span adjustments for use in the field. Power supply shall be 24Vdc. Electronics enclosures shall be rated for operation in Class I, Div. 1 groups C, & D areas.
C. Manufacturer's Service Engineer:
   1. Furnish the services of an experienced service engineer on the Site to verify proper installation and assist in start-up, checkout, calibration, and meter proving.
   2. Furnish the services of an experienced service engineer to instruct Owner's operating personnel on proper operation, maintenance, and repair of Equipment. This instruction time and trip to the Site shall be in addition to the requirements of "1." above.

METER

Meter Data	Offloading
Product	Jet Fuel
API Gravity	43.0
Connections - inches	

diameter, 150-lb ASME raised face.	4
Flow rate – GPM	450
Nonreset totalizer	X
Reset type, large numeral counter reading in whole gallons	X
Right angle drive unit	X
Mechanical automatic temperature compensation for 43 API product 0-150oF.	X
Mechanical flow rate indicator registering in gallons per minute.	X
Photoelectric pulse transmitter capable of 200 pulses per gallon signal.	X

2.11 SUMP SEPARATORS:

A. General Requirements: 50-gallon tank with two adjacent pumps, valves, and piping used to separate water and dirt from fuel discharged from storage tanks or pressure vessels.

B. Construction:

1. Tank capacity shall be 50 gallons.
2. Unit shall be internally epoxy coated.
3. Provide two centrifugal pumps with valves and piping as detailed for moving water to the off-spec product tank and returning fuel to the storage tank. Pumps shall be 10 gpm, 60-foot head with starter in explosionproof box. Motor shall be 230/460 volts, 60 hertz, 3/4 hp, single-phase explosionproof with a temperature code of T3. Motors shall be controlled with manual on/off disconnect switch. Switches shall be factory sealed, explosion proof, and capable of being locked in the off position.
4. Provide sight glass and ball stop with stainless steel fittings.

2.12 SURGE ABSORBER:

A. Contained bladder style charged with nitrogen designed to absorb line shock and limit pressure surges to 250 psig due to instantaneous valve closures within the fueling system.

B. Designed to have a net gas capacity of 25 gallons. Liquid to be jet fuel with a specific gravity of 0.81 $\pm$0.05.

C. Construction shall be as follows:

1. Carbon steel chamber to be rated at 275-psig working pressure in accordance with the ASME Pressure Vessel Code.
2. Removable stainless steel top shall include charging valve and pressure gauge.

3. Bladder to be Buna-N conforming to MIL-R-6855. Furnish one spare bladder.
4. Connection shall be 4-inch, ASME Class 150 raised face flange.
5. The piping connection shall be provided with an energy dissipation device designed to provide unrestricted flow into the vessel and restricted flow from the vessel.
6. Absorber shall be provided with charging and gauging assembly.

2.13 BALL JOINTS:

A. Ball joints shall be constructed of carbon steel with nickel plated ball sealing surface.
B. Ball joints shall be Type N, Style I with unpacked joint. Joint shall include a bolted retainer for disassembly during maintenance or seal adjustment.
C. Working Pressure shall be full vacuum to 275 psig.
D. End connections shall be buttwelded.

PART 3 - EXECUTION

3.01 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all Equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Retighten all bolted and threaded connections after installation.

3.02 INSPECTIONS:

A. The Work will be inspected by Owner at intervals appropriate to the stage of construction during the course of construction.
B. Provide for inspection by all others having jurisdiction over the work performed under the various Sections of these Specifications during the proper phase.
C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.03 START-UP, MOTORS AND DRIVES:

A. Check all motors and drives carefully for correct rotation and alignment before placing Equipment into operation.
B. Disconnect and realign couplings before placing into service or testing.

3.04 ADJUSTMENTS AND CALIBRATION:

A. Adjust all valves for the flows, level settings, and pressure settings indicated and specified.
B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed. Final adjustments shall be made during system operation prior to final start-up.
C. Final adjustments shall be made during system operation prior to final start-up.
D. Adjust all items at start-up, including flow rates, pressure settings, meter settings, and other variables as required.

3.05 TUBING INSTALLATIONS:

A. Assemble using Hy-Fer-Set presetting device as recommended by manufacturer.
B. Route as required to interconnect the instrumentation provided.

C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system.

3.06 GAUGES:

A. Install where indicated on the Drawings.

3.07 VALVE AND EQUIPMENT INSTALLATION:

A. Install where indicated on the Drawings and in accordance with manufacturer's recommendations.
B. Replace any and all valves and Equipment that prove defective during testing.
C. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.
D. Install all butterfly valves with the disc shaft in the horizontal axis.
E. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.
F. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.08 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.
B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.09 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, Contractor and Subcontractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of manufacturer shall be carried out completely.
C. All tested equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item shall be repaired or replaced and put into proper operation immediately.
E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF SECTION 33 52 48

SECTION 33 52 50 - FUEL SYSTEM PUMPS

PART 1 - GENERAL

1.01 SUMMARY:
A. This Section includes pumps applicable to the fuel system.

1.02 RELATED REQUIREMENTS:
A. Section 33 52 43 - Fuel System General Requirements.
B. DIVISION 26 - Electrical Work.

1.03 REFERENCES:
A. American Petroleum Institute (API):
1. STD 610 - Centrifugal Pumps for General Refinery Service.
2. STD 676 - Positive Displacement Pumps - Rotary
3. STD 682 - Pumps-Shaft Sealing Systems for Centrifugal and Rotary Pumps.
4. RP 686 - Recommended Practice for Machinery Installation and Installation Design.
B. American Bearing Manufacturers' Association (ABMA).
C. Institute of Electrical and Electronics Engineers (IEEE):
1. 841 - IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors-Up to and Including 370 kW (500 hp).
D. National Electrical Manufacturers' Association (NEMA):
1. MG1 - Motors and Generators.
E. National Fire Protection Association (NFPA):
1. 70 - National Electrical Code.

1.04 SUBMITTALS:
A. General: Submit as specified in Section 33 52 43.
1. Product data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories including external relief valve for positive displacement pumps. Indicate pump's operating point on curves.
2. Shop Drawings showing pump and motor layout and connections. Include setting drawings with templates, directions for installation of foundation and anchor bolts, and other anchorages.
3. Shop drawing of motor including junction box locations with conduit connections sizes, motor dimensions.
4. Pump and motor coupling drawings.
5. Installation and operation manuals for pumps and motors.
6. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating between manufacturer-installed wiring and field-installed wiring.
7. Dimensioned drawings including the baseplates with anchor bolt layout.
8. Installation instructions including instructions for the installation and grouting of the baseplates and alignment of the pumps.
9. Product certificates of pumps, certifying accuracies under specified operating conditions and compliance with specified requirements.
10. Maintenance data for pumps to include in the operation and maintenance manual specified in Section 33 52 43. Include installation and startup instructions.
11. Motor and Accessories Listing.

12. Motor:
    a. Certified copies of test results.
    b. Torque and speed curves.
    c. Acceleration time with connected load.
    d. Starting capabilities.
    e. Thermal capacity data necessary to determine wait time before start.
    f. Thermal limit curve.
    g. Hot and cold safe stall time.
    h. Inrush current.
    i. Installation, operation, and maintenance manual.

1.05 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with provisions of the following:
   1. API STD 610 for centrifugal pump design, manufacture, testing, and installation.
   2. NEMA MG 1 for electric motors and NEMA MG 1, Part 31 for inverter-duty motors. Include NEMA listing and labeling.
   3. NFPA 70 for electrical components and installation.

B. Single-Source Responsibility: Obtain each category of pumps from one source and by a single manufacturer. Include responsibility and accountability to answer questions and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

C. Manufacturer's Qualification: Firms regularly engaged in manufacture of equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. All pumps shall be receive and stored in a dry location. This includes Owner, Contractor and Subcontractor furnished pumps.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. Comply with pump manufacturer's rigging instructions.

E. Connect and operate motor space heaters during storage as recommended by motor manufacturer.

F. Rotate motor shafts at prescribed intervals during storage per manufacturers recommendations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Vertical Turbine Pumps:
      a. Floway.
      b. Ruhrpumpen.
      c. Flowserve.
      d. Approved equal.
   2. Self-Priming Centrifugal Pumps:
      a. Gorman Rupp Pumps.
      b. Approved equal.
   3. Motors:
      a. ABB.

b. Nidec Motor Corporation (U.S. Motors).
c. GE.
d. Siemens.

2.02 VARIABLE FREQUENCY DRIVE (VFD) OPERATED HYDRANT CAR TEST STAND PUMP (TP-1):

A. General Requirements: Pump shall be a tank-mounted, API VS1 "wet pit" type vertical turbine pump designed and manufactured to operate in a Jet A fuel system. Pump shall be complete with pump, motor, coupling, accessories, and all other parts and materials necessary for a complete installation. Provide 5-gallons of pump manufacturer approved oil as specified for the climate of the installation location.

B. Performance Characteristics:
1. Pumps shall be suitable for operation at the fluid temperature and head conditions listed at any flow between 25% to 120% of design flow. Pump minimum continuous stable flow (MCSF) shall not exceed 25% of design flow at design head.
2. The preferred pump design operating point shall be 120% of the pumps' best efficiency point (BEP).
3. Impellers shall be full size (trimmed to maximum diameter per manufacturer to prevent harmonic vibration issues). The pump's VFD shall be programmed to limit the pump's speed and motor's current to the full load amp draw to prevent motor overload and exceeding the pump's horsepower rating.
4. Pump shall be designed for both continuous and intermittent operation.
5. Pump efficiency shall be a minimum of 75% at BEP or as otherwise indicated and scheduled. Refer to Pump Schedule Appendix in this Section for additional requirements.

C. Pump Instrumentation:
1. Pump bearing temperature and vibration transmitters shall be provided as recommended by the pump manufacturer, should the pump manufacturer take exception to the pump bearing temperature and vibration transmitters specified in Section 25 30 01 (Instrumentation for Fuel Systems).
2. Pump bearing temperature and vibration transmitters shall provide warning alarms and automatic shutdown of the pump through setpoints programmed in the Programmable Logic Controller (PLC). The pump service engineer shall establish the warning alarms and automatic shutdown setpoints during the commissioning of the pump. Bearing temperature and vibration shall be data logged relative to the associated pump's speed. Two vibration transmitters shall be provided and mechanically attached to the pump bearing housings: one in the vertical and one in the horizontal.
a. Bearing temperature transmitter shall be a 3-wire RTD, with 4-20 mA transmitter for connection to Fuel System Programmable Logic Controller (PLC).
b. Vibration transmitters shall be velocity transmitters, with 4-20mA transmitter for connection to the Fuel System Programmable Logic Controller (PLC).
c. Pump vibration base line shall be established by the pump manufacturer during the performance test and vibration readings shall be taken in accordance with API. Documentation of the test and vibration readings shall be provided with the pumps certified data.
d. Field confirmation of appropriate vibration and temperature alarm setpoints shall be provided by pump manufacturer's service engineer during observation of actual pump operations.

D. Construction:

1. Pumps shall meet the requirements of API 610, latest edition.
2. Casing shall be provided with ASME Class 300 raised face flanged end suction connection and ASME Class 300 raised face flanged top discharge piping connection.
3. Impeller and shaft shall be 12% chrome steel, and all other materials of construction shall be per API 610 S-6 material classification.
4. Mechanical seals shall be John Crane Type 1B or approved equal.
5. Bearings shall be designed for 100,000 hours minimum life under design conditions and shall limit impeller and shaft deflection to 0.002-inch maximum. Bearing lubrication systems shall be provided and installed such that there is no visible leakage of lubricating oil on the outside of the pump casing.
6. Provide temperature and vibration sensing to shutdown pump upon high temperatures and excessive vibration.
7. Couplings shall be rigid type, with sufficient spacer length to permit maintenance or removal of the mechanical seal and/or rotating element without removing the motor or disturbing the piping connections.
8. Casing shall have tapped openings with plugs for vent, gauge, and drain connections.

E. Inverter-duty Pump Motors:
1. Motors shall be as follows: Installed in a NEC Class I, Division 2, Groups C and D hazardous location. Sliding contacts, centrifugal, or other type switching mechanisms (including motor overcurrent, overloading, and overtemperature devices), or integral resistance devices which may be provided shall be approved for installation in a Class I, Division 1 location in accordance with the NEC. Pump motor must be listed (UL listed or listed by other approved third-party testing agency acceptable to the authority having jurisdiction) for Class I, Division 2, Groups C& D hazardous locations. Motor must include the nameplate for the same.
2. Motor Characteristics:
   a. 460V, 3 phase, 60 hertz
   b. RPM: 3600
   c. Motor shall have a T3 temperature code or greater (maximum temperature of 200ºC).
   d. Inverter-duty motors shall be variable torque (10:1).
   e. Altitude: 1,000 feet.
   f. Ambient temperature: 40ºC.
   g. Motor shall have insulation per MG-1, Part 31, with 1,600-volt insulation.
   h. Vendor's proposal shall include an add option to insulate both bearings of each motor.
   i. Motors shall be compatible with VFD controllers and approved for area classification by both the motor and VFD manufacturers.
   j. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10% above and below rated voltage. Pump motor speed will be operated from 60% to 93% of full speed at 60 Hz (40Hz to 56Hz).
   k. Inverter-duty motors shall include electrically insulated bearings (all bearing) and a grounding system that continuity between the rotors and ground while maintaining the area classification of the inverter-duty motors.
   l. Shall have performance characteristics which will allow, without injurious over-heating of the motor, accelerating the WK^2 of the load from standstill to rated speed under conditions of six starts per hour.

m. Shall be NEMA Design B (normal-torque, low starting current) squirrel-cage induction type suitable for use with reduced voltage autotransformer starter or across-the-line starter.
n. Insulation shall be non-hygroscopic, NEMA Class F with Class B design temperature rise (at a 1.15 service factor). Stator windings shall be epoxy impregnated by vacuum pressure impregnation (VPI).
o. Motors shall have nominal efficiency equal to or greater than that stated in NEMA MG1, Part 31, Table 12-12, for that type and rating of motor.
p. Enclosure shall be totally enclosed, fan cooled (TEFC) suitable for outdoor installation. Furnish with UL rated automatic drain/breather assembly.
q. Motor space heater shall be single phase / 60 Hz / 120 VAC.
r. Furnish with motor winding thermostats/temperature switches (not RTDs), which are normally closed (NC) during normal state of motor and open when winding temperature rises above winding temperature limit for classified area.
s. Bearings shall be grease lubricated ball bearings with ABMA L10 life of 60,000 hours when running at the specified operating conditions. Zerks shall be located on exterior of motor housing such that lubrication may be performed without any housing disassembly required. Automatic grease reliefs shall be supplied to allow for automatic relief in the event of excess grease.
t. The dynamic balance, overspeed capability, and sound power levels of motors shall conform with NEMA standard requirements.
u. Pump motors shall be furnished with lifting lug(s) on the motor casing.
v. 480 V motor terminal box shall be suitably sized for a 2-inch conduit entrance as shown on the drawings. Lugs shall be provided within box for motor leads and equipment ground. Main terminal box mounting shall be F-1.
w. Motor winding thermostat leads, and space heater leads shall be terminated in an auxiliary box mounted on a terminal strip on the opposite side of the main conduit box with an approximately 1-inch conduit entrance.
x. Auxiliary box mounting shall be F-2. All leads shall be clearly and permanently identified.
y. Motor coating: manufacturer standard epoxy coating.
z. Pump manufacturer shall furnish Engineer with the recommended minimum run time for the motor-pump combination and current vs. time curves on log-log paper.
aa. Motor shall comply with IEEE 841.

F. Tests:
1. Shop tests shall be conducted on all pumps in the manufacturer's shop in accordance with API 610.
2. Perform hydrostatic pressure test and performance test in accordance with API 610.
3. Furnish performance curves of head, horsepower, and efficiency at all flow rates from shutoff to 120% of design flow.
4. Furnish shop test reports and submit to Engineer including performance curves specified in this Section certified by the test engineer.

G. Manufacturer's Service Engineer: Furnish the services of an experienced service engineer on the jobsite to verify proper installation, assist in start-up and testing, and instruct Owner's operating personnel. Service engineer shall be present to observe and approve pump setting as well as alignment.
1. Service engineer shall commission the hydrant cart test stand pump. Commissioning shall include establishing ‘warning alarm’ and ‘automatic shutdown/alarm’ setpoints for

vibration and temperature for each pump. Service engineer shall coordinate with the system integrator in establishing setpoints.

H. Design based on pump manufactured by Floway, Model VS1 12JKM.

2.03 SELF-PRIMING CENTRIFUGAL PUMPS (OP-1 AND OP-2):

A. General Requirements: Pump shall be radially split case, single-stage, horizontal, end suction, overhung, centrifugal design with an integral variable capacity priming feature, manufactured specifically for handling jet fuel. Pumps shall be complete with pump, motor, coupling, mounting base, accessories, and all other parts and materials necessary for a complete installation. Provide 5-gallons of manufacturer approved oil as specified for the climate of the installation location.

B. Performance Characteristics:
   1. Performance shall be identical for all similar service pumps.
   2. Pumps shall be suitable for operation at the fluid temperature and suction head conditions listed at any flow between 25% to 120% of design flow.
   3. Total dynamic head shall be at maximum at no flow and decrease continually from no flow to design flow. Performance curves shall permit stable parallel operation of multiple pumps of the same type.
   4. Pump shall be designed for both continuous and intermittent operation.
   5. Pump efficiency shall be a minimum of 60%.
   6. Pump shall be provided with an integral priming assist valve to remove excessive air from the system so as to allow “self-priming” of the pump.

C. Construction:
   1. Casing shall be constructed of cast steel.
   2. Bearings shall be ball type, lubricated with constant level oiler. Bearings shall be designed for 100,000 hours minimum life under design conditions and shall limit impeller and shaft deflection to 0.002-inch maximum. Bearing lubrication systems shall be provided and installed such that there is no visible leakage of lubricating oil on the outside of the pump casing or on the pump baseplate.
   3. Couplings shall be Thomas XTSR71, or approved equal, with sufficient spacer length to permit maintenance or removal of the mechanical seal and/or rotating element without removing the motor or disturbing the piping connections.
   4. Casing shall have tapped openings with plugs for vent, gauge, and drain connections.
   5. Baseplate shall be of fabricated structural steel shapes suitable for mounting and maintaining alignments of pump, coupling, coupling guard, and motor.
   6. Motors shall be as follows: Motors will be installed in a NEC Class I, Division 2, Group D hazardous location. Sliding contacts, centrifugal, or other type switching mechanisms (including motor overcurrent, overloading, and overtemperature devices), or integral resistance devices which may be provided shall be approved for installation in a Class I, Division 1 location in accordance with the NEC. Pump motor must be listed (UL listed or listed by other approved third-party testing agency acceptable to the authority having jurisdiction) for Class I, Division 2, Group D hazardous locations and the motor must include the nameplate for the same.
   7. Motor Characteristics:
      a. 460 V, 3 phase, 60 Hz.
      b. 3450 rpm.
      c. Shall have service factor of 1.15.

d. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10% above and below rated voltage.
e. Shall have performance characteristics which will allow, without injurious over-heating of the motor, accelerating the WK2 of the load from standstill to rated speed under conditions of six starts per hour.
f. Shall be NEMA Design B (normal-torque, low starting current) squirrel-cage induction type suitable for use with solid state reduced voltage starter or across-the-line starter.
g. Insulation shall be nonhygroscopic, NEMA Class F with Class B design temperature rise (at a 1.15 service factor). Stator windings shall be epoxy impregnated by the vacuum and pressure process.
h. Motors shall have nominal efficiency equal to or greater than that stated in NEMA MG1, Table 12-10, for that type and rating of motor.
i. Enclosure shall be totally enclosed, fan cooled (TEFC) suitable for outdoor installation. Furnish with automatic drain/breather assembly.
j. Furnish with space heaters rated for 120Vac use.
k. Furnish with motor winding temperature switches.
l. Bearings shall be grease lubricated ball bearings with ABMA L10 life of 60,000 hours when running at the specified operating conditions. Zerks shall be located on exterior of motor housing such that lubrication may be performed without any housing disassembly required.
m. The dynamic balance, overspeed capability, and sound power levels of motors shall conform with NEMA standard requirements.
n. Pump motors shall be furnished with lifting lug(s) on the motor casing.
o. 480 V power motor terminal box shall be suitably sized for a 1-1/2-inch conduit entrance. Terminals shall be provided within box for motor leads and equipment ground.
p. An ancillary junction box shall be provided for motor winding temperature switch leads and spare heater leads. The junction box shall be sized for a 1-inch conduit entrance.
q. All leads shall be clearly and permanently identified and provided with suitable terminal lugs.
r. Motor must have a temperature code of T3 (maximum temperature of 200°C).
s. Space heater temperature shall not exceed 80% of the autoignition temperature of Jet A and shall be marked on the motor nameplate. Otherwise, space heaters must be rated for Class I Division 2 atmosphere.
t. Pump manufacturer shall furnish Owner with the recommended minimum run time for the motor-pump combination and current vs. time curves on log-log paper.

D. Tests:
1. Furnish performance curves of head, horsepower, and efficiency at all flow rates from shutoff to 120% of design flow for all pumps.
2. Furnish shop test reports and submit to Engineer.

E. Manufacturer's Service Engineer: Furnish the services of an experienced service engineer on the jobsite to verify proper installation, assist in start-up and testing, and instruct Owner's operating personnel. Service engineer shall be present to observe and approve pump setting and grouting as well as alignment.

F. Design based on pump manufactured by Gorman-Rupp, Model Roto-Prime RD4A-B-1.

PART 3 - EXECUTION

3.01 INSPECTIONS:

A. The Work will be inspected by Owner at intervals appropriate to the stage of construction during the course of construction.
B. Provide for inspection by all others having jurisdiction over the Work performed under this Section of the Specifications during the proper phase.
C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.02 MOTOR SPACE HEATERS:

A. Motor space heaters shall be energized temporarily or permanently within seven days after receipt of pump motors by Contractor.

3.03 INSTALLATION:

A. Install pumps where indicated on the Drawings and in accordance with manufacturer's recommendations, API RP 686, and API STD 610.
B. Replace any and all Equipment items that prove defective during testing.
C. Provide epoxy grouting of pump baseplates unless otherwise approved. The epoxy grout shall have a minimum seven day design strength of 14,000 psi.

3.04 START-UP, MOTORS AND DRIVES:

A. Check all motors and drives carefully for correct rotation and alignment before placing Equipment into operation.
B. Disconnect and realign couplings before placing into service or testing.

3.05 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all Equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Provide coupling alignment records indicating parallel and angular dial indicator readings as well as coupling manufacturer's tolerances. Alignment for pumps, couplings, and drivers requiring "cold" and "hot" settings shall be checked in both conditions and so indicated on the alignment record.
D. Retighten all bolted connections after installation.

3.06 GAUGES: Install where indicated on the Drawings.

3.07 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.
B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.08 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, the Subcontractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of the manufacturer shall be carried out completely.
C. All tested Equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item as a result of Subcontractor's work shall be repaired or replaced and put into proper operation by Subcontractor immediately.
E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF SECTION 33 52 50

SECTION 33 52 51 - FUEL SYSTEM FILTRATION

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers filtration components applicable to the fuel system.

B. Extent of Work shall be as follows:

1. All special valves, pilots, fittings, equipment, and other items, shall meet the following requirements:
   a. Be furnished, installed, tested, and put into successful operation.
   b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and related items, whether shown on the Drawings or not, but required.
   c. Meet the requirements of applicable codes and standards as specified.
2. Piping connected to Equipment which must vary from the Drawings shall be furnished and installed as required to make a complete and workable installation without additional cost to Owner. This requirement includes changes due to the selection of a different Equipment manufacturer than what is indicated on the Drawings, specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
3. Spare, Replacement or Additional Parts:
   a. Where spare, replacement or additional parts are required for the Equipment specified herein, these items shall be delivered to Owner immediately upon receipt at the Site.
   b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
   c. Provide an inventory list of the items delivered to Owner.

C. This Section covers filtration related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, -20ºF to 100ºF, and having a specific gravity of 0.81.

1.02 RELATED REQUIREMENTS:

A. Section 33 52 43 – Fuel System General Requirements.

B. DIVISION 26 – Electrical Work.

1.03 REFERENCES:

A. American Society for Testing and Materials (ASTM):
1. A53 - Pipe, Steel, Blade and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. A216 - Carbon Steel Castings Suitable for Fusion Welding for High-Temperature Service.

B. American Society of Mechanical Engineers (ASME):
1. B16.11 - Forged Fittings, Socket-Welding and Threaded.
2. B16.34 - Valves - Flanged, Threaded and Welding End.
3. Section VIII of Code.

C. American Petroleum Institute (API):
1. 600 - Steel Gate Valves, Flanged and Buttwelding End.
2. 607 - Fire Tests for Soft-Seated Quarter-Turn Valves.
3. 609 - Butterfly Valves, Lug Type and Wafer Type.
4. 1529 - Aviation Fueling Hose.

D. American Bearing Manufacturers' Association (ABMA).
E. Energy Institute (EI):
   1. 1541 - Requirements for internal protective coating systems used in aviation fuel handling systems.
   2. 1581 - Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators.
F. Factory Mutual Engineering Division (FM).
G. Military Specifications:
   1. MIL-R-6855 - Rubber, synthetic, sheets, strips, molded or extruded shapes.
H. National Electrical Manufacturers' Association (NEMA).
I. Oil Companies Materials Association (OCMA).
J. Local governing code.

1.04 QUALITY ASSURANCE:

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves and equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
B. All Subcontractor supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Strainers:
      a. Titan Flow Control.
      b. Hayward.
      c. Mueller Steam Specialty.
      d. Weamco.
      e. Approved equal.
   2. Filter Separators:
      a. Facet.
      b. Velcon.
      c. Approved Equal.

2.02 STRAINERS:

A. Body shall be basket style with threaded drain.
B. Body shall be carbon steel with a 275-pound working pressure.
C. Piping connections shall be ASME Class 150 raised-face flanged. Connections shall be in-line.
D. Basket shall be stainless steel with 5/32-inch-diameter holes lined with 40-mesh stainless steel screen.
E. Differential Pressure Gauge:
   1. Provide (2) 3/8" NPT connections in strainer body for differential pressure gauge tubing.

2. Provide (2) instrument valves in accordance with Section 33 52 47.
3. Provide a 3-way test valve feature.
4. Provide differential pressure gauge in accordance with this Section. Gauge shall be graduated 0 to 15 psi.
5. Provide gauge tubing in accordance with Section 33 52 45.

2.03 FILTER SEPARATORS:

A. General Requirements: Horizontal filter separator for removing free and entrained water and solid contaminants in conformance to API/EI 1581, Latest Edition, Category "C", Type "S" requirements. The vessel shall be designed for two-stage operation containing coalescer and separator cartridges.

B. Performance Characteristics: Maximum rated flow rate shall be 1,000 gpm.

C. Tests:
1. Shop tests shall be conducted on the filters separator in the manufacturer's shop in accordance with the standards of the ASME Code.
2. Furnish certified shop test reports and submit to Engineer.
3. Perform hydrostatic pressure tests of the vessel at 150% of the maximum design pressure.

D. Construction:
1. Vessels shall be designed and fabricated of carbon steel in accordance with Section VIII of the ASME Code. Filter separator vessels shall be designed and stamped for 275 psig maximum allowable working pressure (MAWP) at or above 100ºF.
2. Head closure shall be removable for access to cartridge elements. The assembly shall include swing-type, cadmium-plated eye bolts attached to the shell compatible with slotted bolt clips attached to the head. A hydraulic jacking device with pivot assembly capable of smoothly raising, lowering and rotating the head assembly shall be provided.
3. All wettable components inside the vessel shall be epoxy coated conforming to EI 1541 to a dry film thickness of 5.0 to 7.0 mils.
4. Coalescer cartridges shall be inside/outside flow. Separator cartridges shall be outside/inside flow. Cartridge shall be screw mount.
5. Cartridge chamber shall be provided with positive draining to the sump. Cartridge removal will be from the back of the vessel.
6. Piping connections shall be ASME Class 150 raised-face weld-neck flanges. Inlet and outlet connections shall have Gammon Kit No. 7 millipore test taps on the side. Inlet and outlet connection sizes shall be 6 inches.
7. Water detection probes:
   a. Single stage detection:
      (1) Design Requirements: Water detection system shall be single state, 120VAC, explosion proof, UL-listed intrinsically safe water probe capable of being tested in its operating position.
      (2) System shall have two (minimum) relay contacts (120Vac, 10A continuous).
      (3) Water detected #1 (normally closed, contact opens on water detection to remove power to control valve solenoid).
      (4) Water detected #2 (normally open, contact closes on water detection to indicated status to programable logic controller). Contact used at 24Vdc.
      (5) Acceptable Manufacturer: Manufacturer and model shall be Gammon GTP-1750-5-1-3-1-3-3-3-5 (based on probe model GTP-9330) with additional contacts indicated or approved equal.

8. Air eliminator shall be 1-inch Armstrong with stainless steel body and cover, stainless steel float, and Buna-N seat. A Gammon Technical Products GTP 1294 check valve shall be installed above the air eliminator. A manual air vent shall be provided between the air eliminator and the vessel. A tee connection shall be provided with a ball valve as specified herein and threaded plug.
9. Pressure relief valve shall be of carbon steel construction, shall include ASME BPVC Section VIII code stamp, 1 inch nominal size, with ASME Class 150 raised-face flanges, set at 275 psig. Provide with upstream and downstream isolation ball valves, capable of being locked open, and valved test connection as detailed.
10. Provide direct-reading differential pressure gauge assembly mounted directly on the vessel, complete with Gammon Technical Products GTP-534-PB-30S gauge (or apporved equal), valves, and stainless steel tubing and fittings.
11. Provide manufacturer standard size bottom drain connection and ¾-inch minimum sized drain connections on bottom of inlet and outlet connections.
12. Manual sump drain ball valve shall be provided. Ball valves shall be as specified in Section 33 52 47.
13. Provide 4-inch clean-out connections with victaulic coupling and plug.
14. Differential Pressure Indicating Transmitter: Refer to Section 25 30 01 – Instrumentation for Fuel Systems.
15. Provide one extra set of filter media for each vessel.

E. Manufacturer's Service Engineer: Furnish the services of an experienced service engineer to verify proper installation, assist in start-up, flushing, and testing, and instruct Owner's operating personnel.

PART 3 - EXECUTION

3.01 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Retighten all bolted connections after installation.

3.02 INSPECTIONS:

A. The Work will be inspected by Owner and/or Contractor at intervals appropriate to the stage of construction during the course of construction.
B. Provide for inspection by all others having jurisdiction over the work performed under the various Sections of the Specifications during the proper phase.
C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.03 ADJUSTMENTS AND CALIBRATION:

A. Adjust all valves for the flows, level settings, and pressure settings indicated and specified.
B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed. Final adjustments shall be made during system operation prior to final start-up.
C. Final adjustments shall be made during system operation prior to final start-up.

D. Adjust all items at start-up, including flow rates, pressure settings, meter settings, and other variables as required by Owner and/or Contractor.

3.04 TUBING INSTALLATIONS:

A. Assemble using Hy-Fer-Set presetting device as recommended by the manufacturer.
B. Route as required to interconnect the instrumentation provided.
C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system.

3.05 GAUGES:

A. Install where indicated on the Drawings.

3.06 VALVE AND EQUIPMENT INSTALLATION:

A. Install where indicated on the Drawings and in accordance with manufacturer's recommendations.
B. Replace any and all valves and Equipment that prove defective during testing.
C. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.
D. Provide spool pieces or spacers in the piping as necessary to ensure valve parts and operators have sufficient operating clearances.
E. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.07 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.
B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.08 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, Subcontractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of the manufacturer shall be carried out completely.
C. All tested Equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item as a result of Subcontractor's Work shall be repaired or replaced and put into proper operation by Subcontractor immediately.
E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF SECTION 33 52 51

SECTION 33 52 53 - INSPECTION, TESTING, AND FLUSHING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the inspection, testing, and flushing of all fuel system piping, testing of corrosion protection coatings, and Equipment performance.

B. Provide for the "Gas Free" conditions required by Section 33 52 45, as applicable to the Work of this Section.

C. Filling of new and modified fuel system piping with fuel shall not occur until within 30 days of the respective system portions being placed in service. Reflushing of new and modified fuel system piping is required where fuel has remained stagnant for 30 days or more. Nitrogen charge to 10 psig new and modified fuel system piping which has been completed and will remain out of service longer than 6 months. Appropriate charging fittings and a monitoring pressure gauge with isolation valve shall be provided for all pipe sections requiring nitrogen charging.

1.02 REFERENCES:

A. Airlines for America (A4A):
   1. ATA Spec 103 - Standards for Jet Fuel Quality Control at Airports.

B. American Society for Testing and Materials (ASTM):
   1. D1655 - Specification for Aviation Turbine Fuels.
   2. D2276 - Test Methods for Particulate Contaminants in Aviation Turbine Fuels.
   3. D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels.

C. American Society of Mechanical Engineers (ASME):
   1. B31.3 - Process Piping.

1.03 SUBMITTALS:

A. Submit detailed procedures for testing methods for approval before proceeding with pipe fabrication. This includes all radiographing and other pipe welding NDE, pressure testing, holiday testing, and flushing.

B. Submit examination personnel qualifications before proceeding with any testing method.

C. Submit completed examination procedures with actual testing data (readings) and signatures of examination personnel.

1.04 QUALITY ASSURANCE:

A. All tests (radiographing and other pipe welding NDE, pressure testing, holiday testing, and flushing) shall be performed in accordance with ASME B31.3.

PART 2 - PRODUCTS – Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL:

A. Compressors used for air testing shall have sufficient capacity to bring the system under test up to the test pressure in a maximum of 20 minutes.

B. Procedures:

1. Perform holiday testing of coating systems on all piping including joints.
2. Pneumatically test fuel piping.
3. Hydrostatically test fuel piping.
4. Flush fuel piping.
5. Electrically test all insulating flanges and joints.
6. Water shall not be used for testing fuel piping.
7. Perform preliminary pneumatic tests and final hydrostatic fuel tests before piping joints are concealed with backfill or other construction. Variances from this may be allowed but must be approved by Owner and Engineer.

3.02 FUEL PIPING PNEUMATIC PRESSURE TEST:

A. A pneumatic test shall be applied in accordance with ASME B31.3 to the entire length of buried fuel pipe installed under this Contract.
B. All pneumatic testing shall be done using dry compressed air at -20°F dew point.
C. Install temporary closures or other fittings, including Victaulic coupling caps, blind flanges, and similar items, as necessary for the integrity of the piping system to be tested. Permanent valves and adapters shall be in place for testing.
D. Backfill between joints before application of test pressure.
E. The pressure shall be gradually increased until a gauge pressure which is one-half the test pressure, 5 psig, is attained, at which time a preliminary check shall be made, including examination of exposed joints in accordance with ASME B31.3. Thereafter, the pressure shall be gradually increased in steps until the test pressure of 10 psig is reached, holding the pressure at each step long enough to equalize piping strains.
F. Maintain 10 psig pressure for at least 2 hours.
G. Soap exposed joints and carefully inspect to detect leaks.
H. Pressure and temperature reading shall be taken as follows:
   1. Temperatures shall be representative of actual conditions.
   2. Readings shall not be taken during times of rapid atmospheric changes.
   3. There shall be no indication of reduction in test pressure after corrections for temperature and pressure have been made according to the relationship $T_1 P_2 = T_2 P_1$, where T and P are absolute temperatures and pressures and subscripts refer to initial and final readings.
I. Repair defective joints and repeat tests until approved.

3.03 FUEL PIPING HYDROSTATIC PRESSURE TEST:

A. Apply a liquid pressure test with a grade of aviation kerosene fuel approved by Owner to the entire fuel system following the pneumatic pressure test.
B. The pressure shall be gradually increased until a gauge pressure which is one-half the test pressure, 150 psig, is attained, at which time a preliminary check shall be made, including examination of exposed joints in accordance with ASME B31.3. Thereafter, the pressure shall be gradually increased in steps until the test pressure of 275 psig is reached, holding the pressure at each step long enough to equalize piping strains.
C. The test pressure of 275 psig shall be maintained for a 24-hour period on all buried fuel piping, and 4-hour period on the aboveground fuel system.
D. Repair any leaks in a manner approved by Owner.
E. Provide calibrated temperature and pressure instruments and chart recorders to provide continuous temperature and pressure readings variations during the tests. Instruments shall be calibrated for temperature and pressure immediately prior to each test. Recorder charts shall be submitted to Owner for review prior to final acceptance of the piping.

F. Permanent valves and adapters which are rated for the test pressure shall be in place for the liquid pressure test. Equipment which is not rated by the manufacturer for the test pressure shall be removed prior to testing. Install temporary connections as necessary.
G. For final tie-in welds, NDE of the welds and in-process welding examination in accordance with ASME B31.3 and Section 33 52 45 and careful observation of the system piping put under operating pressure with fuel before joints are covered will satisfy the requirement for this testing. This includes points of system interconnection.

3.04 INSPECTION OF COATINGS:

A. A detailed inspection with a holiday tester shall be conducted on all pipe coating and joint coating for below ground pipe preceding the lowering of the pipe.
B. Holiday-tester voltage shall not be higher than the manufacturer's recommended voltage for the coating tested. Testing shall be for holidays only and not to test the dielectric strength of the coating materials.
C. All holidays and damaged or broken places in the coating shall be repaired in a workmanlike manner.
D. All holidays shall be patched using the methods specified for field-applied external protective pipe coating and procedure in Section 33 52 46.

3.05 TESTING OF INSULATED FLANGES AND JOINTS:

A. Each insulating flange and joint assembly shall be tested with an approved ohmmeter.
B. Ohmmeter used shall have at least 20 megohms, full-scale deflection when using the meter's highest dc resistance multiplier setting.
C. Ohmmeter tests shall be made when flange assembly is dry using the highest multiplier setting and shall indicate infinity measured between each stud and both flanges.
D. Each insulating flange assembly shall be field tested after installation and shall be tested not higher than the manufacturer's recommended voltage.

3.06 FUEL HANDLING:

A. Provide documents inventorying the fuel removed from the system for drain downs, flushing, etc. The documents shall record the volume of fuel contained in the tanker trucks and temporary portable storage tanks provided by Subcontractor and removed from the fueling system to complete the Work. The tanker trucks and temporary portable storage tanks shall be made available to the Owner for witnessing the inventorying of the same. Owner will inventory Subcontractor-furnished vacuum trucks, when applicable. Fuel shall not be removed from airport property without Owner signed documents recording the fuel being removed from airport property.
B. Do not waste, spill, or contaminate the fuel used for testing, filling the system piping, completing tie-ins, drain-downs, flushing, and other Work requiring fuel to be removed from the fueling system or handled.
C. Transport acceptable fuel and offload the fuel back in to the operating storage tanks at the airport fuel storage facility. Fuel that is unacceptable (fuel quality acceptance determination by Owner) shall be removed from the Site and disposed in accordance with regulations.
D. Provide certified clean, detergent free (steam cleaned) temporary portable tanks, tanker trucks, etc. for storing and transporting fuel removed from the system. Interior coatings of temporary portable tanks, tanker trucks, etc. used shall be compatible with Jet A fuel.

3.07 FLUSHING:

A. Before a new, modified, or repaired fuel system, or portion thereof, is placed into service, all piping affected by change shall be flushed to ensure system cleanliness before aircraft fueling is permitted.
B. All flushing procedures, fuel sampling and testing shall be in accordance with ATA 103, latest revision.
C. A reasonable amount of fuel required for flushing and testing will be supplied by Owner. Owner will arrange for delivery of the fuel.
D. Product used for flushing shall meet ASTM D1655, latest revision, specifications for kerosene Jet A/A-1 type aviation grade turbine fuels.
E. Desired flow rate of flush is 10 feet per second minimum unless a lesser rate is agreed upon by airline quality assurance representative. Additional temporary pumps and filters, if required to provide minimum flow velocity, shall be provided by Subcontractor.
F. No flushing will be allowed through control valves, meters or hydrant pit valves.
G. Test samples shall be drawn immediately ahead of filtration on closed loop recirculation systems; immediately ahead of storage tanks in receiving manifold on recirculation systems returning flushed fuel to tankage; or immediately ahead of transport trucks or frac tanks on single line systems.
H. Where possible, temporary piping connections to form a closed loop piping system shall be installed and the system flushed by means of recirculation. All temporary cross connections or special fabrication of adapters required shall be provided by Subcontractor.
I. For flushing into tank trucks or frac tanks, Subcontractor shall supply any temporary manifolds plus sufficient number of single compartment tanks or tank trucks and hoses to allow the desired flow rates to be achieved in a safe manner. Hoses and couplings shall be aircraft type with a minimum 300 psig rating and shall be hydrostatically tested. Four-inch (4-inch) hose size (multiple manifolded hoses if required) shall be used to achieve flow capacities during flush.
J. All general service valves and adapters shall be in place throughout the flushing procedure. Subcontractor shall remove control valves and metering assemblies prior to initiating flush.
K. Provide all filtration media required for return of fuel to the airport fuel storage facility following the system flush. This includes intermediate filtration media changeouts if excessive media loading or disablement occurs during return of flushed fuel to the fuel storage facility. Upon completion of flush and return of flushed fuel to the airport fuel storage facility, provide new filtration media if replacement is determined necessary by the Owner due to filter element loading from the return of flushed fuel.
L. Flushing into Tank Trucks or Frac Tanks:
    1. Temporary diesel-driven pumps shall be used for the flushing procedure if required to meet the required flushing flow rate.
    2. A temporary filtration system shall be used for the flushing procedure.
    3. Procedure:
        Caution: All electrical and motorized equipment in area should be shut down in case of a mishap or fuel spill. For safety, all persons not involved in the flushing operation shall be kept a minimum of 100 feet away from tank trucks and hydrant pits used in the flushing operation.
        a. Tank truck internal valves and non-locking frac tank butterfly valves should be safety wired in an open position.
        b. Dry break couplers shall be provided for all hoses feeding into trucks. Hoses shall have flanged ends where dry breaks are not needed.

c. All quick-release type couplings shall be safety wired when coupled to the bottom load receptacle and hydrant adapter.
d. Hoses shall be secured in a manner to prevent whipping during flush.
e. Bond truck or tanks to fuel system piping.
f. Start product flow slowly before reaching flushing velocity to check for leaks and system tightness.
g. Fire extinguishers shall be in place in case of emergency.
h. Location of test personnel:
(1) One person per each tank or truck to monitor fuel level in tank.
(2) One person at each valve to control fuel flow into tank or truck.
(3) One person at each pump control station to shut down pumps in emergency.
(4) One person manning fire extinguisher(s).
(5) One person removed from manual tasks in command of flushing operation.

M. Flushing may be accomplished by flushing fuel from the supply storage tank, through the pumping/filter system, around the closed loop piping system, to the receiver storage tank.
N. The system pumps and filtration of the Offload and HCTS fueling systems may be used for the flushing procedure of those systems.
O. Acceptance Specifications:
1. At a minimum shall be in accordance with section 3.15.3 of ATA Spec 103.
2. Visual - All fuel samples shall be clear and bright. Other visual clues must be observed and acted upon accordingly, i.e.; feel, color, odor, and similar characteristics. This test shall be performed in accordance with ASTM D4176.
3. Perform a membrane test per ASTM D2276. A minimum of 1 gallon of jet fuel shall be used for this test. Visually assess the membrane and compare it with a color rating booklet. The color shall be a maximum of #3 Rated Wet with a particulate contamination not exceeding the B scale. Flushing shall continue and the membrane test repeated, until a minimum of two consecutive samples are obtained which meets these requirements; the system volume shall be displaced between the two consecutive passing samples.
Note: If color rating exceeds the above limits or is in dispute, a matched weight gravimetric rating not to exceed 0.5 mg/gal shall govern.
4. Water - 5 ppm maximum.
5. Water Separation (Microsep) Rating - 85 minimum.

P. Final Acceptance:
1. It shall be the responsibility of the airline fuel quality assurance representative, or their designee, to have final decision on system cleanliness and acceptance before aircraft fuel servicing is permitted.

Q. After flushing has been completed and approved, remove all temporary cross connections and related items, and install control valves, metering elements, strainer baskets, and other system components. Replace all filter media and clean the interior of aboveground fuel storage tanks after flushing and return of fuel to storage has been completed. The entire facility shall be received in a new and clean condition as described previously.

3.08 PERFORMANCE TESTING:

A. The entire fueling system shall be subjected to operating tests as required by Owner, to demonstrate satisfactory functioning and operating efficiency.
B. Tests shall include checks to determine that all control valves and switches are properly adjusted.
C. Testing shall include the functions of the complete electrical system.

D. All instruments required to conduct the tests shall be furnished by Subcontractor.
E. All tests may be witnessed by a representative of Owner.
F. Submit typed samples of test reports to Owner for approval.
G. Submit completed test reports.

END OF SECTION 33 52 53

SECTION 33 56 41 - SHOP FABRICATED ABOVEGROUND STORAGE TANKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Specification includes the requirements for single-compartment cylindrical horizontal welded double-wall steel shop fabricated tank systems for aboveground storage. Tank systems to be provided and contents are as follows:
   1. Reclaim Tank 1 (RT-1) for reclaimed Jet A storage at Fuel Storage Facility.
B. The fuel storage tanks shall be horizontal, cylindrical, welded steel tanks for aboveground storage of fuel as indicated.
C. Tanks shall be located and oriented on a concrete pad as indicated.
D. Each tank shall be equipped with vents, manways, and appurtenances specified and indicated.
E. Nozzle and appurtenance locations shall be as indicated subject to potential adjustment by Engineer prior to fabrication.
F. Provide all items necessary for a complete, functional tank system to store fuel including storage tanks, tank accessories, and supports.
G. Tanks shall be UL listed as follows:
   1. Reclaim Tank 1 (RT-1) shall be UL-142.
H. Each component of the tank system shall be UL listed where UL maintains a listing for the component type and as required by the local authority having jurisdiction.
I. The tank is to be used for storage of aviation turbine jet fuel per ASTM D1655 specification, known as Commercial Jet-A with a specific gravity of 0.81 ±0.05.

1.03 RELATED REQUIREMENTS:

A. Section 25 30 01 - Instrumentation for Fuel Systems.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 33 52 43 - Fuel System General Requirements.
D. Section 33 52 44 - Identification of Fuel Piping and Equipment.
E. Section 33 52 45 - Fuel System Pipe, Connections, and Installation.
F. Section 33 52 46 - Fuel System Coatings for Corrosion Protection.
G. Section 33 52 47 - Fuel System Valves.
H. Section 33 52 48 - Fuel System Accessories.
I. Section 33 52 50 - Fuel System Pumps.
J. All control and instrumentation provisions for fuel systems shall be accomplished under the direction of the qualified control system Subcontractor described in Section – 25 50 01.

1.04 REFERENCE STANDARDS:

A. Applicable Codes and Standards:
   1. American National Standards Institute (ASME):
      a. B1.20.1 - General Purpose Pipe Threads.
      b. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      c. B16.5 - Pipe Flanges and Flanged Fittings.
   2. American Petroleum Institute (API):
      a. MPMS 2.2A - Measurement and Calibration of Upright Cylindrical Tanks by the Manual Strapping Method.

b. MPMS 2.2A - Petroleum and Liquid Petroleum Products - Calibration of Horizontal Cylindrical Tanks - Part 1: Manual Methods.

3. Underwriters Laboratories (UL):
   a. 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
   b. 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids.
4. National Electrical Manufacturers Association (NEMA).
5. National Fire Protection Association (NFPA):
   a. 30 - Flammable and Combustible Liquids Code.
   b. 30A - Automotive and Marine Service Station Code.

1.05 SUBMITTALS:

A. Submit as specified in Section 33 52 43.

A. Submittal shall include the following.
   1. Tank specifications, showing construction and location of all fittings.
   2. Manufacturer-field interface.
   3. Anchor bolt and foundation requirements.
   4. Tank appurtenances.
   5. Tank accessories.
   6. Internal and external coatings.
   7. Installation and start-up instructions and maintenance data for inclusion in the project maintenance manual.
   8. Certified strapping charts for tanks.
   9. Test reports.
   10. Tightness testing results.

B. Submit all items for approval before incorporation into the work. Prepare resubmittals as required to receive approvals.

1.06 QUALITY ASSURANCE:

A. All Equipment and Materials shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials for a minimum of 5 years.

B. When two or more units of the same class of Equipment are required, they shall be products of a single manufacturer. Probes, sensors, and the automatic tank gauging (ATG) system shall all be by the same manufacturer, unless otherwise specified.

C. All Subcontractor supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Tanks:
      a. Highland Tank & Mfg. Co.
      b. Approved equal.

2. Hand Pump:
   a. Tuthill Transfer Systems (Fill-Rite Series 5200).
   b. Approved equal.
3. Emergency Vent:
   a. OPW, A Dover Company.
   b. Morrison Bros. Co.
   c. Clay and Bailey Mfg. Co.
   d. Approved equal.
4. Gauge Hatch:
   a. OPW, A Dover Company.
   b. Morrison Bros. Co.
   c. Approved equal.
5. Pressure/Vacuum Vent:
   a. OPW, A Dover Company.
   b. Morrison Bros. Co.
   c. Approved equal.
6. Automatic Tank Gauge (ATG):
   a. Veeder-Root (TLS-300C).
   b. Franklin Fueling Systems.
   c. Approved equal.
7. Interstitial Sensor:
   a. Veeder-Root.
   b. Franklin Fueling Systems.
   c. Approved equal.
8. High Level Alarm:
   a. Veeder-Root (TLS Overfill Alarm).
   b. Franklin Fueling Systems.
   c. Approved equal

2.02 ABOVEGROUND STORAGE TANKS (AST):

A. Fabricate conforming to UL 142 with steel conforming to ASTM materials, grades and thicknesses. Tanks shall be shop fabricated single-compartment cylindrical horizontal welded double-wall steel construction. Tank heads shall be flat. Exterior and interior seams shall be continuously welded on the side to be coated. Tanks shall meet the requirements of and be acceptable to the local Fire Marshal and other local governing authorities.

B. Tank Dimensions:
   1. Reclaim Tank 1 (RT-1):
      a. Overall Dimensions (Outer Tank): 31'-2" dia by 10’-8" long.
      b. Nominal Capacity: 20,000 gallons.

C. Prior to shipment, prepare surfaces, prime coat and finish coat interior and exterior of tank and appurtenances. Exterior shall be coated with manufacturer’s standard polyurethane and the interior shall be completely lined with manufacturer’s standard epoxy. Tank epoxy linings shall be compatible with the product stored and meet EI 1541 testing requirements.

D. Identify tank system as specified in Section 33 52 44.

E. Lifting lugs shall be provided at the balance points.

F. Provide anchor bolts for tanks. Coordinate quantity, size, location of anchor bolts and foundations.

G. Tank saddles and wear plates shall be in accordance with the latest edition of UL 142. Tanks shall ship with the saddles and wear plates welded to the tanks.

H. Provide tank openings and connections necessary for proper operations to include those indicated and as specified below. Provide approved anti-siphon devices in each external pipe connected to the tank when the pipe extends below the level of the top of the tank in accordance with NFPA 30. Spill boxes shall contain a minimum of 5 gallons. Provide striker plates on tank bottoms under all openings as identified on the drawings.
   1. Reclaim Tank 1 (RT-1):
      a. Primary tank emergency vent.
      b. Secondary tank emergency vent (outer tank only).
      c. One 36-inch manhole with access ladder.
      d. One 30-inch manhole
      e. One 4-inch level alarm.
      f. One 4-inch stick gauge (manual).
      g. One 4-inch liquid level gauge (ATG).
      h. One 12-inch pump mounting nozzle.
      i. One 6-inch fill line, to extend into tank as indicated.
      j. One 4-inch pressure/vacuum vent.
      k. One 4-inch spare.
      l. One 2-inch water drawoff pump connection.
      m. One 2-inch threaded connection for interior leak monitoring well.

I. Tank openings, piping connections, and tank accessories shall be furnished as indicated.
   1. Flanged openings shall be ASME B16.5, Class 150 with composite gaskets, with the exception of piping connection, which shall have gaskets, nuts, and bolts in accordance with Section 33 52 45.
   2. Flanged openings shall be provided with blind flanges during shipment.
   3. Threaded openings shall be sealed with plugs during shipment.
   4. Tank nozzles and manways shall be designed to support the load of the connected Equipment.

J. Provide a maintenance platform along the length of the top of each tank for access to all tank nozzles and tank accessories. Size and width of maintenance platform shall be as indicated on the drawings. Provide 3'-0" wide field mounted stairs from pad level to platform level. Provide OSHA complaint ladders, platforms, and stairs, with handrails. Platforms, stairs, ladders, and handrails shall be constructed of structural shapes and grates of ASTM carbon steel materials. Platforms shall provide access to and clearances from manways and all other tank appurtenances. Platforms, stairs, ladders, and handrails shall be coated with manufacturer's standard polyurethane.

K. Provide a permanent sign at the fill point for the tank documenting the filling procedure and the tank calibration chart. The filling procedure shall require the person filling the tank to determine the gallons required to fill the tank to 90% of capacity before commencing the fill operation.

2.03 HAND PUMP:

A. Hand pump shall be piston design and shall be suitable for handling water and Jet A.

B. Pumping capacity shall be a minimum of 20 gallons per 100 push/pull strokes.

C. Pump shall be designed to pull at least 10 inches of mercury when dry priming, and provide at least 11 feet of suction lift for the indicated fluids.

D. Pump shall be provided with integral vacuum breaker to prevent siphoning.

E. Pump shall be UL listed.

2.04 EMERGENCY VENT:

A. Provide emergency venting based on actual interior tank dimensions provided and per NFPA 30 requirements. Stored fluid shall be Jet A. The tank connection for the emergency vents shall be sized per the capacity of the emergency vents provided.
B. Provide mushroom style top with screen.
C. Top and base shall be constructed of cast iron. Vapor seals shall be Buna-N

2.05 GAUGE HATCH:

A. Provide a 4-inch side seal type adapter and cap with NPT connections.
B. Adapter shall be of brass construction; cap shall be aluminum.
C. Provide calibrated tank gauging sticks

2.06 PRESSURE/VACUUM VENT:

A. Provide an aluminum body pressure/vacuum vent with brass screen.
B. Vent shall mount on a vent pipe and direct vapors upward.

2.07 AUTOMATIC TANK GAUGE (ATG):

A. System shall include a magnetostrictive probes manufactured by Veeder-Root or approved equal.
B. System shall continuously monitor the tank liquid level and storage capacity in gallons.
C. ATG systems shall monitor tank interstitial sensors.
D. System shall include water detection.
E. Probes shall be UL listed.

2.08 INTERSTITIAL SENSOR:

A. Provide 2-inch tank nozzle for sensor.

2.09 HIGH LEVEL ALARM:

A. System shall include and audible and visual alarm with alarm acknowledgement switch.
B. Alarm shall include an adjustable on time.
C. Level switch shall be Magnetrol model TD2. Output voltage to horn and strobe shall be 120 VAC.
D. Provide 1-inch NTP nozzle level switch.
E. High level alarm set point shall be 95% of tank capacity, size as indicated.

2.10 STRAPPING CHARTS AND STICK GAUGES:

A. Provide certified strapping tables to Owner for each tank provided. A paper copy and a digital copy in PDF format of each strapping table shall be provided.
B. Table shall indicate tank volume in gallons for each 1/16-inch.
C. Strapping charts shall be adjusted for slope of tanks as indicated.
D. Provide two (2) gauge sticks having a 1/8-inch graduation.

2.11 GROUNDING

A. Grounding connections to tanks shall be as identified by tank manufacturer. Refer to Section 26 05 26 for additional grounding requirements.

2.12 PUMPS:

A. Refer to Section 33 52 50 for pump specifications.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Tanks and Equipment shall be installed per manufacturer's written recommendations and installation instructions, recognized industry standards, and federal, state, and local codes including, but not limited to, NFPA 30.
B. Provide housekeeping pads, to level tank on sloped pad or foundation as specified and indicated.
C. High level switch delay shall be set to zero.
D. Slope tanks as indicated.
E. Spare connections shall be properly secured:
   1. Provide permanent metal plugs sealed with nonhardening pipe sealant to internal bushing threads, for all unused threaded piping couplings.
   2. Provide metal blind flanges with gaskets for all unused flange connections.

3.02 HANDLING AND STAGING:

A. Tanks shall be handled and staged in accordance with the tank manufacturer’s written instructions.

3.03 TESTS:

A. Primary tank and interstitial space shall withstand an independent air pressure test and differential air pressure procedure applied in the manufacturer's shop. At the manufacturer’s shop, the primary/inner tanks shall be air tested to 5 psig along with a soap solution applied to the tank nozzles shop and a differential air pressure test on the interstitial secondary/outer tanks. The air pressure shall hold for a period of 4 hours without a drop after the test apparatus has been removed. Submit shop test results to Engineer.
B. After tank is set on its foundation, perform 5 psig air test of the primary/inner tanks followed by differential air pressure test of the secondary/outer tanks. Hold each air test for 4 hours. Tests shall not be performed simultaneously. Consult and follow tank manufacturer’s air pressure test procedure. Calibrated pressure gauges shall be used having a span from zero to 10 psig having 1 psig increments.
C. Any leakage or other defects shall be considered a failure of these tests. Necessary repairs shall be made upon failure and the test shall be repeated until all defects are eliminated as acceptable to the tank manufacturer and Engineer.
D. Submit field test reports to Engineer.

3.04 MANUFACTURER'S FIELD SERVICES:

A. Provide the services of an experienced service engineer on the jobsite to verify proper tank system installation, assist in start-up and testing, and instruct fuel system operator's personnel in the operation of the ATG system.

3.05 CERTIFICATION:

A. Provide a certification letter to the Engineer certifying that the tank system is constructed in accordance with applicable standards, including NFPA 30 and UL 142. Tanks shall include

nameplates listing the manufacturer's name, address, model and serial numbers, tank capacity, and UL listings. Metallic nameplates shall be permanently affixed to the tanks.

END OF SECTION 33 56 41

SECTION 33 56 43 - FUEL SYSTEM ABOVEGROUND STORAGE TANKS (FIELD FABRICATED)

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the design, fabrication, and erection of aboveground fuel storage tanks and steel containment shells.

B. The storage tanks and steel containment shells shall be vertical, cylindrical, welded steel tanks for aboveground storage of fuel.

C. Each storage tank shall be equipped with a supported cone roof, and appurtenances specified. Each steel containment shell shall be equipped with appurtenances specified.

D. Nozzle and appurtenance locations shall be as shown on Drawings subject to potential adjustment by Engineer prior to fabrication.

E. The storage tanks are to be used for storage of aviation turbine jet fuel per ASTM D1655 specification, known as Commercial Jet A with a specific gravity of 0.81 ±0.05. However, tank design shall be based upon a product with a specific gravity of 1.0. Steel containment shell design shall be based upon a product with a specific gravity of 1.0.

F. Shop Drawings and tank calculations shall be performed and sealed by an Oregon-regestered Professional Engineer experience in the design of API 650 tanks.

G. Storage tanks and steel containment shells shall be designed, fabricated and erected in accordance with API 650 (where applicable for steel containment shell) for seismic criteria applicable to Portland, Oregon and Oregon DEQ Seismic Stability requirements. Minimum Seismic Importance Factor and Seismic Load Coefficients are indicated under Structural General Notes on Contract Drawing S-001.

H. Storage tanks and steel containment shells are are assumed to require anchor bolts. Tank and containment anchorage details and locations shall be designed by Tank Subcontractor. Tank and containment foundation design and details shown on structural plans are preliminary and will be finalized after receipt of anchor bolt loadings from Tank Subcontractor. See Contract Drawing S-001 for associated requirements.

1.02 RELATED REQUIREMENTS:

A. Section 21 13 39 – Low Expansion Foam Systems

B. Section 33 52 43 – Fuel System General Requirements.

C. Section 33 52 46 – Fuel System Coatings for Corrosion Protection.

1.03 REFERENCES:

A. Applicable Codes and Standards:

1. American Society for Testing and materials (ASTM):
   a. A36 - Carbon Structural Steel.
   b. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   c. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   d. D1655 - Standard Specification for Aviation Turbine Fuels.
2. American Society of Mechanical Engineers (ASME):
   a. B31.3 - Process Piping.
3. American Petroleum Institute (API):
   a. 650 - Welded Steel Tanks for Oil Storage.
   b. 653 - Tank Inspection, Repair, Alteration and Reconstruction.
   c. Manual of Petroleum Management Standard (MPMS) Chapter 2.

4. National Fire Protection Association (NFPA):
   a. 11 - Standard for Low-, Medium-, and High-Expansion Foam.

1.04 SUBMITTALS:

A. Provide Shop Drawings for approval on the storage tanks, steel containment shells, and all accessories and appurtenances.
B. Submit design tank and containment anchor bolt loadings as soon as possible after contract award to allow tank foundation design to be finalized.
C. Submit storage tank strapping charts after tanks are erected and field measurements have been made.
D. Provide a complete set of fabrication and erection drawings of the storage tanks and steel containment shells at the Site which are to be kept up to date as as-constructed drawings during erection. At completion of erection, a complete electronic set of corrected as-constructed erection drawings shall be provided to Owner.

1.05 QUALITY ASSURANCE:

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of aboveground storage tanks, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 10 years.
B. Welding Inspector – Provided by Subcontractor:
   1. Submit documentation that the independent welding inspector is a Certified Welding Inspector (CWI) and an ASNT Central Certification Program (ACCP) NDT Level II, qualified to adequately inspect all tank welds required to be inspected by radiography, liquid penetrant or magnetic particle testing in accordance with API 650.
   2. The inspector shall remain certified during the entire project. The Owner and Contractor shall be notified of any changes in certification status within 10 calendar days of the change. The inspector shall provide complete documentation of all inspections and results directly to the Owner and Contractor.
C. All supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with manufacturer's rigging and installation instructions.
B. Special Precautions:
   1. The tank erector shall give special consideration to, and include adequate provisions for, prevention of storage tank and steel containment shells damage during erection, due to high winds. Suitable structural bracing of the shells, both internally and externally, shall be provided and used at all times to prevent damage from winds.
   2. If damage from winds does occur, such as shell buckling or collapse, repairs shall be expedited to ensure minimal or no negative impact to the construction schedule. All additional materials required shall be provided and repair work performed at no cost to Owner. Any construction schedule time extensions resulting from wind damage shall result in no additional cost to Owner.

3. Any necessary repairs shall be performed in accordance with API 650 and API 653 as a minimum. Additionally, all damaged plates shall be replaced at the discretion of Owner. Final acceptance of any required repairs shall be by Owner. Note that visible defects, resulting from wind damage and allowed by the API standards may not be acceptable to Owner, potentially requiring repair or replacement of shell or bottom plates at no cost to Owner.

1.07 SPECIAL PROJECT WARRANTY:

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Aboveground Storage Tanks and Containment Shells:
      a. Chicago Bridge & Iron Company.
      b. American Tank & Vessel, Inc.
      c. Advance Tank and Construction Company.
      d. Pasadena Tank.
      e. Fisher Tank Co.
      f. Approved equal.
   2. Pressure/Vacuum Vent:
      a. Shand and Jurs.
      b. Groth Equipment Company.
      c. Varec.
      d. Approved equal.
   3. Gauge Hatch:
      a. Shand and Jurs.
      b. Groth Equipment Company.
      c. Varec.
      d. Approved equal.
   4. Swing Joint:
      a. Staytite (National Oilwell Varco).
      b. SwingMaster (Matrix Applied Technologies).
      c. Approved equal.

2.02 FABRICATION AND MATERIALS:

A. Storage Tank Bottoms:
   1. Fabricate of steel plates conforming to ASTM materials, grades, and thickness as specified by API 650.
   2. Joints shall be lap welded on the upper side with continuous full fillet welds. Laps shall be in direction of sump.
   3. Pitch bottom from periphery to center water draw-off sump.

B. Storage Tank Shell:
   1. Fabricate of steel plates conforming to ASTM materials, grades, and thickness as specified by API 650.
   2. Lower shell plates shall rest directly on the bottom plates and be connected to them by a continuous fillet weld both inside and outside.

3. Shell joints shall be butt welded with full penetration.
4. Automatic girth welding is permitted providing submerged arc process is used. Girth joints, if not submerged arc welded, shall conform to requirements for Shielded Metal Arc Welding of API 650.
5. Tank shells shall have top angle welded to shell with continuous fillet welds. Reinforcing plates for piping connections shall be sized to compensate for the reaction loads indicated.
6. All opening reinforcing plates shall have a minimum of 12 inches between adjacent plate welds or the nearest adjacent vertical tank shell welds.
7. Intermediate wind girders shall not be permitted.

C. Steel Containment Shell:
1. Fabricate of steel plates conforming to ASTM materials, grades, and thickness as specified by API 650.
2. Shell joints shall be butt welded with full penetration.
3. Automatic girth welding is permitted providing submerged arc process is used. Girth joints, if not submerged arc welded, shall conform to requirements for Shielded Metal Arc Welding of API 650.
4. Containment shells shall have top angle welded to shell with continuous fillet welds. Reinforcing plates for piping connections shall be sized to compensate for the reaction loads indicated.
5. All opening reinforcing plates shall have a minimum of 12 inches between adjacent plate welds or the nearest adjacent vertical tank shell welds.

D. Outside Fixed Roof:
1. Install on the storage tanks a center-supported, fixed cone type roof.
2. There shall be a single center-support open structural shape column to support the cone roof. A pipe or box steel type column shall not be used. Provide wear plate(s) beneath column base (welded to tank bottom plate on all sides). Tank coating shall be applied to top of wear plates and bottom of column base. Column support base shall straddle the center water center sump.
3. Roof shall be designed and constructed according to API 650 and shall be completely weathertight.
4. Fabricated of steel plates conforming to ASTM materials, grades, and thicknesses as specified by API 650.
5. Roof plates shall have lap welded joints, with continuous fillet welds. Roof plates shall be "reverse shingled" as detailed.
6. Provide suitable structural joist members and single center-support column as required by API 650 to make fixed roof a center-supported structure.
7. Orient roof plates and openings to minimize the number of seams cut by openings or appurtenances.
8. See Article 2.03 for additional guard rail (handrail) requirements.

E. Miscellaneous Items:
1. Rods and structural sections shall conform to ASTM A36.
2. Steel pipe, bolting, and gaskets shall conform to Section 33 52 45.

F. Workmanship:
1. Storage tanks and containment shells shall be fabricated, welded, and erected using the best workmanship and tank erection practices.
2. Erection holes in shell plates will not be permitted.

3. All burrs, indentations, and other imperfections on the tank plates shall be filled in and ground smooth in an approved manner.
4. All internal diffusers, open pipe ends, and stilling wells shall be cut perpendicular to centerline, with pipe ends and edges ground smooth in an approved manner.
5. Fabrication and erection procedures shall be subject to inspection by the Contractor. Any material which has been improperly fabricated or, in the opinion of Contractor, is excessively damaged shall be removed and replaced.
6. In addition to the defects listed in API 650 latest edition, the following conditions are defective and detrimental to the safety and appearance of a tank and shall be repaired or removed: plate laminations, dents, and wavy plates or plate edge.

2.03 STORAGE TANK APPURTENANCES:

A. Floating Suction:
1. Suction nozzle connection shall be a Class 150 raised face on the exterior of the tank and Class 150 flat faced on the interior of the tank, double flanged type of the size detailed and fabricated of 1/2-inch wall seamless steel pipe, ASTM A53.
2. Provide full face gaskets and flat faced flanges to connect to the ASME B16.1, Class 125 cast iron flanges of the swing joints. The use of ASTM A307, Grade B, bolting shall be limited to the cast iron flanges of swing joints.
3. Provide a flanged, central-type swing joint. Swing joint to be mounted to the inside flange as detailed.
4. Bushings shall be Ni-Resist and O-rings shall be Viton. Swing joints 30-inch and larger shall be constructed of ductile iron.
5. Provide swing line pipe fabricated of 10-gage aluminum, stainless steel, or carbon steel. Pipe size and length as detailed.
6. Swing pipe inlet shall be provided with a 45-degree pipe suction elbow, light weight or Schedule 10, aluminum, stainless steel, or carbon steel, with pipe extension and flared end inlet as detailed, and antivortex baffles or other turbulence-minimizing devices. Provide small vent hole on top of ell for venting of air upon initial tank fill.
7. A support shall be provided and attached to the tank bottom to provide a stop/support for the floating suction assembly in the full down position. Height of the support shall be such that the suction pipe inlet will be 12 inches above the tank bottom.
8. Provide floats as necessary to ensure flotation of swing line in aviation jet fuel. Floats to be fabricated of 10-gage aluminum, stainless steel, or carbon steel. Design floats to provide 2 foot minimum submergence of suction pipe opening at any position.
9. Pneumatically test floats for leaks.
10. Provide suitably sized stainless steel chain for floating suction restraint as detailed.
11. Provide floating suction position indicator as indicated.

B. Fill Nozzle:
1. Nozzle connections shall be a Class 150 raised face, double-flanged type of the size detailed and fabricated of Schedule 80 seamless steel pipe, ASTM A53. Internal pipe extension of length as detailed.
2. Provide flanged internal pipe diffuser extensions fabricated of ASTM A36 plate steel with a minimum thickness of 1/4-inch. Length and shape shall be as detailed.

C. Low-Suction Arrangement:
1. Low-Suction nozzle shall be a 4-inch, Class 150 raised-face, double flanged connection with internal pipe extension as indicated.
2. Provide a 4-inch double block and bleed plug valve on tank nozzle.

3. Size as specified and fabricated of Schedule 80 seamless steel pipe, ASTM A53.

D. Water Draw Off and Return Arrangement:
   1. Water draw off and return nozzle shall be 2-inch, Class 150 raised-face, double flanged connection with tank internal piping as detailed.
   2. Water Draw Off pipe shall be supported from tank bottom and routed parallel to tank bottom.
   3. Provide water center sump of size indicated.

E. Blind Flanges for Nozzles:
   1. Provide blind flanges with gaskets on all external flanged nozzles to protect flange faces.
   2. The blind flange for the fill nozzle may be drilled and tapped for piping connection for water test fill at manufacturer's option.
   3. Blind flanges shall be left in place and shall become property of Owner. Any openings in flanges shall be plugged.

F. Shell Manhole:
   1. Provide 36-inch-diameter shell manhole with hinged cover. Hinges shall be heavy duty pre-manufactured type. Two manholes required per tank.
   2. Manhole gaskets shall be of fire-resistant composite material.
   3. Manhole nuts and bolts shall be PTFE coated.

G. Spiral Stairway:
   1. Provide a spiral stairway on the outside of each tank.
   2. Stairways and platforms shall consist of approved stair treads constructed of open non-slip grating. Stair treads shall not be directly welded to tank shell with handrails on the outside and runner/kick plates on the inside and outside (double-runner), all rising at an angle of 45 degrees above the horizontal. Welded attachments to the tank shell shall be seal welded with reinforcing pads on the tank shell.
   3. Beyond the reinforcing pad connections to tank shell, stairs, handrails, and similar shall be hot dip galvanized.
   4. Design to safely support a concentrated load of 1,000 pounds at any location.

H. Roof Landing:
   1. Roof landing shall be located at the top of the tank and connected to the tank stairway.
   2. Provide open type grating with an approved non-skid surface.
   3. Provide railing and toe plate on all sides.
   4. Grind smooth rough spots and welds on handrails on stairway and platform.

I. Grounding Lugs:
   1. Provide stainless steel grounding lugs, four per tank, for exothermic type field connection of #2/0 bare copper tank grounding wire.
   2. Grounding lugs shall have minimum of 8 square inches of contact area with tank surface.

J. Roof Manway and Access:
   1. Provide a 36-inch by 36-inch hinged roof manway. Manway shall be designed per API 650, Figure 5.18 (as numbered in 12th Edition). Provide manway complete with exterior padlock hasp.
   2. Provide a 36-inch by 72-inch flanged roof accessway with suitable number of lift-up handles.

K. Guard Rail:
   1. Provide 42-inch-high guard rail, with toeboard around entire roof edge as indicated.
   2. Vertical supports shall be spaced at a maximum of 5 feet apart.
   3. Beyond the attachment to the fixed cone roofs, handrails, balusters, toe boards and similar shall be hot dip galvanized. Handrails and toe boards shall be painted safety

yellow. Galvanized steel surfaces shall be prepared in accordance with the paint manufacturer's written instruction before applying the safety yellow coating.

L. Pressure/Vacuum Vent:
   1. Locate vents on the roof as indicated on the tank appurtenance drawings.
   2. Size to maintain a maximum of 1/2-ounce per square inch pressure or vacuum.
   3. Vent shall be Shand and Jurs Model 94020 breather valve or approved equal.

M. Gauge Hatch:
   1. Provide gauge hatch on outside of fixed roof in location detailed.
   2. Gauge hatch shall be 8-inch flanged type with tight self-closing, spark-proof cover.
   3. Gauge hatch shall be Shand and Jurs Model 95014 or equal.
   4. Gauge hatch shall incorporate a 8-inch-diameter still pipe and zero datum plate as detailed.

N. Automatic Tank Gauging: Provide an 8-inch flanged connection for automatic tank gauging. Connection shall include a 8-inch-diameter still pipe. Pipe shall be attached to the 8-inch connection. Stilling pipe shall be installed plumb and as detailed. Automatic tank gauging system shall be as specified in Section 25 30 01.

O. Automatic Tank Gauging Temperature Probe: Provide a 4-inch flat-faced flanged connection for the automatic tank gauging temperature probe.

P. Tank High-High Level Alarm: Provide a 6-inch flat-faced flanged connection for tank level alarm. Level alarm shall be as specified in Section 25 90 01.

2.04 STEEL CONTAINMENT APPURTENANCES:

A. Suction Nozzle:
   1. Suction nozzle connection shall be a Class 150 raised face on the interior and exterior of the shell, double flanged type of the size detailed and fabricated of 1/2-inch wall seamless steel pipe, ASTM A53.

B. Fill Nozzle:
   1. Nozzle connections shall be a Class 150 raised face, double-flanged type of the size detailed and fabricated of Schedule 80 seamless steel pipe, ASTM A53.

C. Low Suction Nozzle:
   1. Low Suction nozzle shall be a 6-inch, Class 150 raised-face, double-flanged type of the size detailed and fabricated of Schedule 80 seamless steel pipe, ASTM A53.

D. Sump Return Nozzle:
   1. Sump return nozzle shall be a 1-inch, Class 150 raised-face, double-flanged type of the size detailed and fabricated of Schedule 80 seamless steel pipe, ASTM A53.

E. Blind Flanges for Nozzles:
   1. Provide blind flanges with gaskets on all external flanged nozzles to protect flange faces.
   2. The blind flange for the fill nozzle may be drilled and tapped for piping connection for water test fill at manufacturer's option.
   3. Blind flanges shall be left in place and shall become property of Owner. Any openings in flanges shall be plugged.

F. Shell Manhole:
   1. Provide 36-inch-diameter shell manhole with hinged cover. Hinges shall be heavy duty pre-manufactured type. One manhole required per containment shell.
   2. Manhole gasket shall be of fire-resistant composite material.
   3. Manhole nuts and bolts shall be PTFE coated.

G. Spiral Stairway:

1. Provide two spiral stairways on both the inside and outside of each steel containment shell. Each set of internal and external stairs shall be located on opposite sides of the shell (rotated 180-degrees from each other) as shown on the drawings.
2. Stairways and platforms shall consist of approved stair treads constructed of open non-slip grating. Stair treads shall not be directly welded to tank shell with handrails on the outside and runner/kick plates on the inside and outside (double-runner), all rising at an angle of 45 degrees above the horizontal. Welded attachments to the tank shell shall be seal welded with reinforcing pads on the tank shell.
3. Beyond the reinforcing pad connections to tank shell, stairs, handrails, and similar shall be hot dip galvanized.
4. Design to safely support a concentrated load of 1,000 pounds at any location.

H. Stair Landing and Platform:
1. Stair landing and platform shall be located at the top of the containment shell and connected to the internal stairway and the storage tank stairway.
2. Provide open type grating with an approved non-skid surface.
3. Provide railing and toe plate on all sides.
4. Grind smooth rough spots and welds on handrails on stairway and platform.

I. Grounding Lugs:
1. Provide stainless steel grounding lugs, four per containment shell, for exothermic type field connection of #2/0 bare copper tank grounding wire.
2. Grounding lugs shall have minimum of 8 square inches of contact area with tank surface.

2.05 DEWATERING SUMP:

A. Dewatering sump system shall be installed as indicated on the Drawings.
B. Leak detection sensor shall be installed as indicated on the Drawings, and as specified in Section 25 30 01.
C. Hand pump shall be piston design and shall be suitable for handling water and Jet A (aviation kerosene). Pumping capacity shall be minimum 20 gallons per 100 push/pull strokes. Pump shall be designed to pull at least 10 inches of mercury when dry priming, and provide at least 11 feet of suction lift for the indicated fluids. Pump shall be provided with integral vacuum breaker to prevent siphoning. Pump shall be UL listed. Pump shall be Tuthill Transfer Systems Fill-Rite Series 5200 or approved equal.

2.06 LIGHTING SYSTEMS:

A. Lighting system shall be installed as indicated on electrical Drawings and as specified in DIVISION 26.

2.07 FIRE PROTECTION:

A. Fire protection equipment shall be provided as specified in Section 21 13 39 and coordinated with this Section.

2.08 INTERNAL AND EXTERNAL COATING:

A. Internal and external coatings shall be applied as specified in Section 33 52 46.

PART 3 - EXECUTION

3.01 INSPECTION OF WELDED SHELL JOINTS:

A. All storage tank shell and steel containment shell welded joints shall have full penetration and complete fusion.
B. Non-Destructive Examination (NDE):
   1. The tank manufacturer shall provide the services of an independent testing laboratory to perform all radiographic, liquid penetrant and magnetic particle testing. Laboratory to be approved by Subcontractor. Electronic copies of the test results shall be submitted to Contractor directly by the testing laboratory, with copies to the tank manufacturer.
   2. All welded joints shall be visually inspected and accepted by the testing laboratory prior to performing any other NDE. Welds that do not pass visual inspection shall be repaired prior to further inspection.
   3. The testing company's personnel performing the NDE shall be an American Welding Society Certified Welding Inspector (CWI) in addition to ASNT NDT Level II or Level III certification as required by API 650. CWI and NDT certifications shall be submitted to Contractor.
   4. The Owner and/or Contractor reserves the right to employ their own testing laboratory to inspect all welded joints in addition to the Subcontractor provided inspector.
   5. The tank manufacturer shall cooperate with the testing company(s) and provide easy and safe access for the testing personnel and the equipment to perform the inspection.
   6. Shell welds shall be tested by the radiographic method in accordance with API 650.
C. Defective Welds:
   1. If, in the opinion of Owner's representative, any of the radiographs show defective welding, the defective area shall be chipped out and rewelded as directed by Owner's representative.
   2. Burning or melting out of defective welding shall not be permitted unless approved by Owner.

3.02 TESTING OF WELDED JOINTS:

A. All tests may be witnessed by Contractor or Owner.
B. All defects shall be corrected in a manner approved by Contractor and retested to their satisfaction.
C. All tank bottom plate fillet welds shall be subjected to a soap film test, from the inside, using a vacuum device.
D. All shell nozzle reinforcing welds shall be tested pneumatically using soap film or similar material for detection of leaks.
E. All fixed roof welds shall be subjected to a soap film test, from the outside, using a vacuum device.
F. After all joint tests are completed and all appurtenances are installed, the interior of the tank shall be cleaned of all debris and inspected by Contractor prior to further testing.

3.03 WATER TEST:

A. Fill all storage tanks and containment shells with potable water. Water test to be completed prior to painting, or connection of external piping.
B. Any leakage, weepage or other defects, shall be considered a failure of this test.
   1. Upon such failure, the tank shall be drained to a level necessary to make repairs and the test shall be rerun until all defects are eliminated and the tanks are approved by Contractor.
C. The tank manufacturer shall submit a written schedule of the filling operation to the Owner ten (10) days prior to commencing the test, including an estimate of the total filling time.

D. Water service for filling will be the responsibility of Subcontractor.
E. Provide all temporary equipment, accessories, and connections to accomplish the water testing.
F. Each storage tank shall be filled to the top of the shell and then drained to a level 6 inches below the top and the tank then be allowed to stand filled for a five-day period. The water shall then be drained into the containment shell until the level in the containment shell is 6 inches below the top of the shell, and the storage tank filled to equalize the containment shell level. The test shall be allowed to stand filled for a two-day period.
G. Monitor and record settlement measurements of each tank during the water test. Settlement measurements shall be taken at equally spaced intervals not to exceed 32 feet (a minimum of eight points) around the tank and shall be observed by Owner. Record measurements at intervals as required by API 650 Chapter 7.
H. Test water may be reused for subsequent tests.
I. Test water shall be disposed of by Subcontractor.
J. Tank Gauging:
    1. Upon completion of installation of all appurtenances, a strapping firm shall strap tanks, certify their results, and show calculations of reduction in volume due to appurtenances. Tank strapping shall be in accordance with API MPMS Chapter 2, Section 2D (2.2D). Strapping firm shall also indicate liquid volume contained below the zero datum. Zero datum is defined as the intersection of the manual gauge hatch stilling tube centerline and zero datum plate attached to tank bottom. Provide results and strapping charts to Owner. Units and strapping chart graduation shall be as defined by the Owner. As appropriate, provide correction factor between manual and automatic tank gauging datum plates.

3.04 PAINTING:
A. Tanks shall be painted according to the provisions of Section 33 52 46.

3.05 CERTIFICATION:
A. Provide a certification letter with attached as-constructed data sheet for each tank in accordance with API 650.
B. Each tank shall have an API Standard 650 nameplate attached.

END OF SECTION 33 56 43

SECTION 33 56 45 – ABOVEGROUND OIL WATER SEPARATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the design, fabrication and installation of a multi-compartment, welded, single-wall steel shop fabricated oil/water separator (OWS). Systems to be provided and contents and sizing criteria as follows:
   1. Oil/Water Separator:
      a. Sized to produce an effluent with less than 10 parts per million (PPM) of free oil at 40 gpm. A nominal 600-gallon oil/water separator vessel shall be provided.
      b. Preliminary overall dimensions including the integral oil holding capacity and dedicated effluent water compartment are approximately 3 feet width x 3 feet height x 9 feet long.
      c. I-beams shall be provided beneath OWS.

B. Tank shall be aboveground, horizontal, rectangular welded steel, constructed in accordance with UL 142 and labeled in accordance with UL 2215.

C. Tank shall be equipped with vents, removable covers, and appurtenances specified and indicated, subject to potential adjustment by Authority Representative prior to fabrication.

D. Each component of the tank system shall be UL listed where UL maintains a listing for the component type and as required by the local authority having jurisdiction.

E. Provide all materials, labor, and equipment required to install, test, and place into operation oil/water separator as indicated.

F. Provide with the following:
   1. All necessary labor, and equipment required to install, test, and place into operation including nuts, bolts, and gaskets.
   2. All accessories and safety devices required for proper operation.
   3. All manuals, drawings, parts lists, and special tools required for assembly, maintenance, and operation.
   4. Services of manufacturer's qualified installation representative, as required.

1.02 RELATED REQUIREMENTS

A. Section 33 52 43 – Fuel System General Requirements.

B. Section 33 52 45 – Fuel System Pipe.

C. Section 33 52 46 – Fuel System Coatings for Corrosion Protection.

D. Electrical: DIVISION 25 and 26.

1.03 REFERENCE STANDARDS

A. Applicable Standards:
   1. American National Standards Institute (ANSI/ASME):
      a. B1.20.1 - General Purpose Pipe Threads.
      b. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      c. B16.5 - Pipe Flanges and Flanged Fittings.
   2. American Petroleum Institute (API):
      a. 421 - Management of Water Discharges: Design and Operation of Oil-Water Separators.
   3. American Society For Testing and Materials (ASTM):
      a. A36 - Structural Steel.

b. A569 - Steel, Carbon (0.15 Maximum Percent), Hot Rolled Sheet and Strip Commercial Quality.
c. A635 - Steel, Sheet and Strip, Heavy Thickness Coils, Carbon, Hot-Rolled.

4. National Electrical Manufacturers Association (NEMA).
5. National Fire Protection Association (NFPA):
   a. 30 - Flammable and Combustible Liquids Code.
   b. 70 - NEC National Electric Code
6. Petroleum Equipment Institute (PEI):
   a. RP200 - Recommended Practices for Installation of Aboveground Liquid Storage Systems.
7. Society for Protective Coatings (SSPC):
   a. SP 5 - White Metal Blast Cleaning. Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
8. Underwriters Laboratories (UL):
   a. 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids
   b. SU2215 - OWS Design, Construction, and Performance Standards.

1.04 SUBMITTALS

A. Submit as specified in SECTION 33 52 43 – FUEL SYSTEM GENERAL REQUIRMENTS.
B. Compliance submittals required shall include, but are not limited to, the following:
   1. Complete system layout drawing.
   2. Separator and equipment specifications.
   3. Complete details of tanks and piping, including critical dimensions and locations of all fittings, manways, removable covers, and other accessories.
   4. Product data on all components and accessories, including sensors, switches, valves, and pumps.
   5. Bill of materials.
   6. Local control panel/alarm panel drawings, wiring diagrams, and product data.
   7. Strapping chart for oil/water separation compartment.
   8. Dimensional data for oil/water separation compartment detailing elevations for all piping.
   9. Oil/Water Separator manufacturer's installation checklist and warranty.
C. Manufacturer shall submit certification that equipment will comply with performance requirements as specified.
D. Manufacturer shall submit certification that tank has successfully completed shop leakage test.

1.05 QUALITY ASSURANCE

A. All Equipment and Materials shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials for a minimum of 5 years.
B. Installation Subcontractor shall have had a minimum of five years' experience in the installation of oil/water separators of similar type, size and configuration.
C. All supplied pipe, flanges, fittings, bolts, and nuts, which will remain as a permanent part of the Work, shall be manufactured in the U.S.A. and comply with the American Iron and Steel (AIS) requirements of Made and Melted in the U.S.A. Contractor approval of alternate origin of manufacture shall be subject to Engineer approval. Any pipe, flanges, fittings, bolts, or nuts that do not conform to Made and Melted in the U.S.A. are subject to rejection and removal from the project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Oil/Water Separators:
      a. Highland Tank & Mfg. Co.
      b. Enquip, Inc.
      c. PS International.
      d. Approved equal.
   2. Free Vent:
      a. Morrison Bros. Co.
      b. OPW Fueling Components.
      c. Approved equal.
   3. Level Switch (for OWS only)
      a. Magnetrol.
      b. Rosemount.
      c. Approved equal.

2.02 FABRICATION AND MATERIALS

A. Provide an aboveground, horizontal, rectangular, single-wall steel tank conforming to UL 142 with steel conforming to ASTM material, grades and thickness.
B. Separator design shall not permit the liquid level to operate within manways or vent risers.
C. Exterior and interior seams shall be continuously welded on the side to be coated (tank interior and exterior).
D. Tank interiors shall be cleaned and blasted to conform with SSPC-SP5 prior to coating tank interior and piping.
E. All materials, including elastomers and coatings, shall be compatible for long term submergence in jet fuel, diesel fuel and gasoline containing ethanol.

2.03 GENERAL

A. Provide all connections necessary for complete installation as indicated and as specified.
B. Certification Label: Each tank shall bear a permanently affixed certification label which includes the following:
   1. Name of manufacturer.
   2. A unique identification number.
   3. Dimensions, design and working capacity and model number of the tank.
   4. Year of manufacture.

2.04 ABOVEGROUND OIL/WATER SEPARATOR (OWS-1)

A. General Requirements:
   1. Tank shall be aboveground, horizontal, rectangular with physical dimensions of approximately 3 feet width x 3 feet height x 9 feet long.
   2. A corrugated parallel plate separator having a nominal 600-gallon capacity with nominal design flow rate of 40 gpm.
   3. The separator shall be designed in accordance with the American Petroleum Institute (API) Manual on Disposal of Refinery Wastes (Volume on Liquid Wastes, Latest Edition) and with API 421.

4. Construction and thickness of the separator walls shall be in strict accordance with UL 142. Separator shall bear UL label.
5. Construction and performance of the separator shall be in accordance with UL-SU2215.
6. The separator shall have an integral oil holding capacity, and a dedicated effluent water compartment of nominal capacity. A strapping chart of the oil/water separation compartment shall be submitted.
7. The separator shall process uncontrolled surges of water, oil or oil/water mixtures ranging from zero flow up to 100% of maximum hydraulic throughput capacity and provide wastewater effluents, which meet federal, state or local oil and grease discharge requirements of 10 ppm hydrocarbon for at least 5 minutes.
8. The separator vessel shall have internal compartments to include a separation chamber, filtration chamber,and a product sump.
9. Oil decanting will be performed with a fixed pipe riser.
10. I-beams shall be provided beneath OWS. Separator manufacturer shall design to determine adequate size and quantity to be provided.
11. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions.

B. Factory Tests:
1. Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation.
2. An air pressure test shall be applied in the manufacturer's shop at 3 psig, which shall hold for a period of two hours without a drop after the test apparatus has been removed.
3. Furnish certified shop test reports and submit to Contractor.

C. Construction:
1. The inlet connections shall be a 4-inch, Class 150 F.F. flange. Outlet connection shall be 4-inch, Class 150 F.F. flange. Provide vent spools for both inlet and outlet to provide vent piping connection points. Inlet flow shall be diffused to facilitate separation. Inlet and outlet shall be located on separator heads.
2. The separator shall be furnished with fittings for vent, waste oil pumpout, float removal/testing, coalescer access (2), other access covers, and level switches.
3. The separator shall be constructed for transport to Site as one integral unit, less risers, ready for immediate installation (field splicing or field fabrication are unacceptable).
4. Separator lifting lugs shall be located at the balance points.
5. Separator shall be rectangular, constructed of ASTM A36 steel with all seams of double-welded construction (inside and out).
6. Access covers shall be provided complete with covers, gaskets, and bolts.
7. Oil water separator interior shall be completely coated, including internal piping and manway extensions. Internal coating shall be Protective Coating System T-2 (epoxy) as specified in Section 33 52 46. Vessel manufacturer’s standard internal coating system may be accepted if considered by Engineer to be of equal or better quality.

D. Anchoring System:
1. Tank manufacturer shall design and provide tank anchoring system.
2. Provide anchor bolts for separator. Coordinate quantity, size, and location of anchor bolts between separator manufacturer and foundation subcontractor.
3. Submit calculations and details of tank anchoring system design sealed by a current Licensed Professional Engineer to Contractor.

E. Accessories:

1. The separator shall be provided with a removable coalescer pack (in addition to parallel plate separation). Coalescer pack shall consist of oleophilic media (mesh-pack or equivalent). The coalescer shall be designed to intercept oil particles of greater than 20 microns in size and produce an effluent quality of less than 10 ppm of oil and grease to satisfy requirements of the NPDES stormwater discharge permit. The coalescer shall be housed in a stainless-steel frame with means for easy removal through a dedicated manway with required extension, cover, gasket, and bolts.
2. The separator shall have fittings for vents, interface/level sensor, waste oil pump-out, sampling, drain, and gauge.
3. The oil/water separation compartment shall be provided with a dual level switch for high level (oil) and high level (liquid). The high level (oil) shall alarm when oil level in separation chamber reaches maximum oil holding capacity. The high level (liquid) shall alarm when liquid level in separation chamber reaches maximum liquid holding capacity. Upon either occurrence, the yard pump (P-14) shall be shut down.
4. The hydrant pump pad (HPP) containment sump will be provided with a discriminating sump sensor for detection of hydrocarbons in the sump. The sensor will be set so that an alarm occurs upon detection of hydrocarbons, and the yard pump (P-14) shall shut down.
5. Provide free vent with rain cap on all vent risers.

F. Separator shall be charged with water in accordance with manufacturer's recommendations upon completion of installation and any time separator is emptied for maintenance.

2.05 FREE VENT

A. Provide an aluminum body open vapor vent with brass screen.
B. Vent shall mount on a 2-inch vent pipe and direct vapors upward.
C. Vents shall terminate 12 feet above grade.

2.06 LEVEL SWITCHES

A. Level switches shall be Class I, Division 1 Group C & D rated.

2.07 STRAPPING CHARTS AND STICK GAUGES

A. Oil water separator manufacturer shall provide a certified volume chart for the oil/water separation compartment.
B. Chart shall indicate oil/water separation compartment volume in gallons for each 1/4-inch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Oil water separator shall be installed per the manufacturer's current recommendations; recognized industry standards including PEI RP200; and federal, state and local codes.
B. Blind flanges and threaded caps shall be provided on risers as necessary and shall be field tapped to accommodate electrical installation where necessary.
C. Oil water separator shall be positioned and placed as indicated.
D. Prior to placement of tank, any foreign matter shall be cleaned from tank.
E. Spare connections shall be properly secured:
    1. Provide permanent metal plugs sealed with non-hardening pipe sealant to internal bushing threads, for all unused threaded piping couplings.
    2. Provide metal blind flanges with gaskets for all unused flange connections.

F. Oil water separator manufacturer(s) shall have a representative on Site during installation and testing of tank, and manufacturer's representative shall remain until installation and testing are complete.

3.02 FIELD TESTING

A. Submit detailed procedures for testing methods for approval before starting tank installation. This includes all pressure testing and holiday testing.
B. Tanks shall be field tested for leakage immediately prior to installation.
C. Contractor shall be notified 10 days prior to testing. Tests may be witnessed by the Contractor.
D. Tank Coating Inspection and Repair:
    1. A joint inspection by Subcontractor and Contractor shall be performed to identify any coating flaws or damage both internally and externally to the oil water separator. All holidays and damaged or broken places in the coating shall be repaired in a workmanlike manner using the methods specified for field- applied external or internal protective coatings and procedure as recommended in writing by tank manufacturer.
    2. Submit field test reports to Contractor.

END OF SECTION 33 56 45

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Burns & McDonnell World Headquarters
9400 Ward Parkway
Kansas City, MO 64114
O 816-333-9400
F 816-333-3690
www.burnsmcd.com